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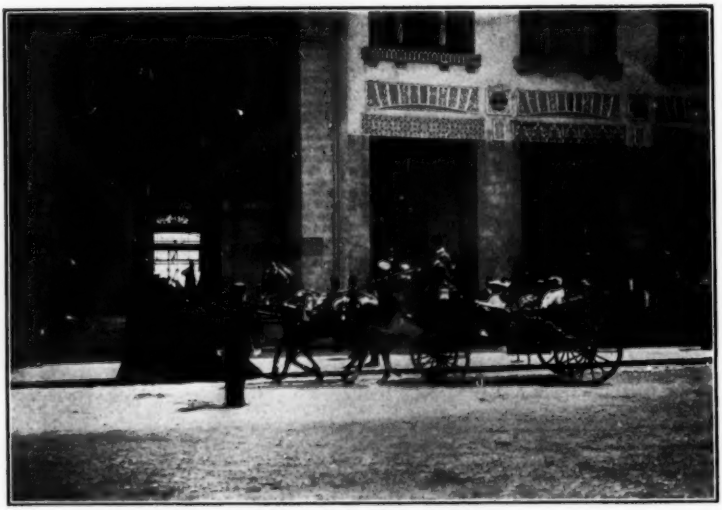
# RAILWAY AND ENGINEERING PROGRESS IN AFRICA.

*By J. Hartley Knight.*

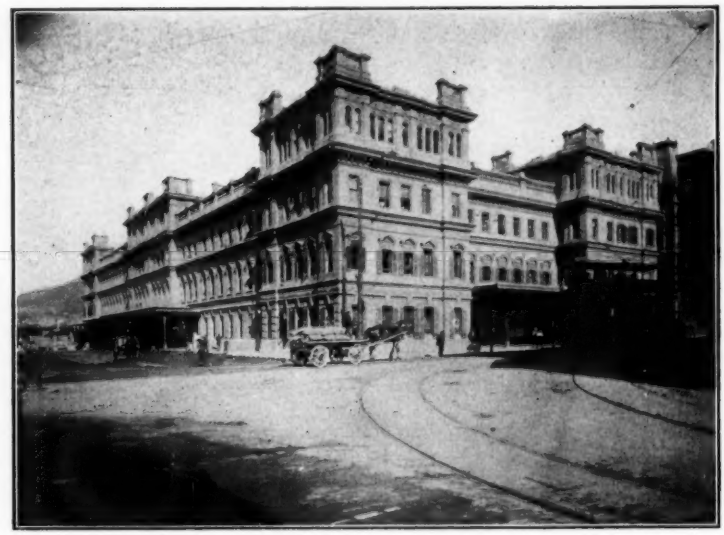
Mr. Knight's article is a brief but highly suggestive review of engineering achievements and engineering opportunities whose extent is perhaps too little appreciated by many of our readers. And the larger significance is that conveyed by our contributor's concluding sentences: 'that (in Africa) only the fringe of railway development has yet been touched, and for many years to come there will be an increasing and vigorous demand for electrical power and mining machinery and the whole range of mechanical equipment and supplies."—THE EDITORS.

IT was, I think, in 1900 that my first article on railway construction in Africa appeared in these pages, and from time to time since I have been permitted to "report progress" as the iron road continued to advance in that continent, the last occasion being exactly two years since. In the decade thus covered a wonderful transformation has been effected and some notable engineering triumphs remain to be recorded—triumphs which stand as a monument of patience, perseverance, and skill on the part of those who, with splendid strenuousness, have pushed their way into the remotest corners of barbarism and brought the head-light of the locomotive to bear on some of the darkest places of the Dark Continent.

In a railway carriage the other day I heard two men discussing this very subject. One was enthusiastic at the way railway engineering had transformed, and was transforming, Africa; the other was disposed to treat the whole thing slightingly. "See the years they have been at it," he observed; "I can't see what there is to crow about: look what has been done in America since *they* first started to build railways and compare it with the total mileage of work actually accomplished in Africa! Why, there's simply no comparison!" Possibly not; but it apparently did not occur to the speaker that the conditions on the continents are not quite the same and that to institute comparisons was not only absurd but also grossly unfair, seeing that



THE RAILWAY STATION, CAIRO.



THE RAILWAY STATION, CAPE TOWN.

These two stations are the termini of the gigantic and by some thought chimerical project of a through north-and-south line across Africa, which Mr. Knight says is now in not the smallest doubt of early completion.

the white population of Africa all told is not to be mentioned in the same breath with that of America, to say nothing of the former's political divisions and the consequent want of co-ordination in dealing with railway affairs.

INTERIOR OF DURBAN STATION, NATAL GOVERNMENT RAILWAYS.

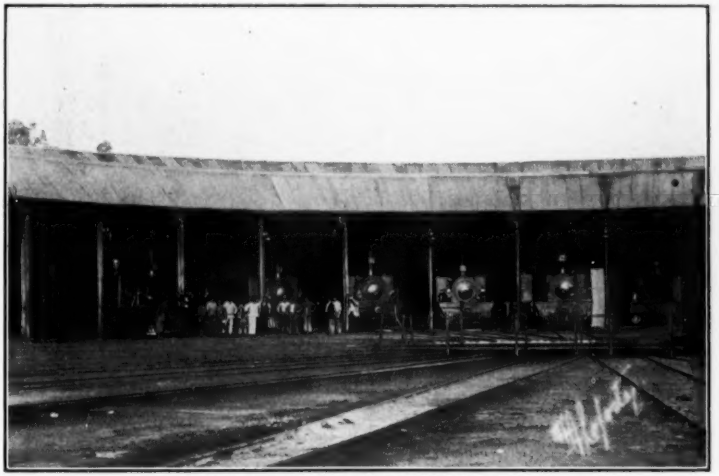
The fact remains that the white peoples of Africa, sparse and scattered as they are, have much to be proud of in the matter of railway development, and especially so in the sub-continent. But when all is said and done the line known as the Cape-to-Cairo Railway—popularly supposed to be the conception of the late Cecil Rhodes—is still the most fascinating and most "fancied" of all the lines in Africa. The object of that railway is not, as Rhodes himself once pointed out, to enable a human being to get in at Cape Town and get out at Cairo. Rather is it "to cut Africa through the centre," so that the railway "will pick up trade all along the route. The junctions to the east and west coasts, which will occur in the future, will be outlets for the traffic obtained along the routes of the line as it passes through the centre of Africa." And slowly, but none the less surely, that cutting process is still going on, to the chagrin of those who predicted a dismal failure of the whole scheme after Rhodes's death, and the astonishment of the croakers who stigmatised the idea as chimerical almost from its very conception.

ABOVE, BUILDING TELEGRAPH LINE, RHODESIA BROKEN HILL. BELOW, BWANA-MKUBWA FESTIVITIES, RHODESIA-CONGO FRONTIER.

The terminus of the Cape-to-Cairo route was at Broken Hill for several years. The line crossed into Belgian territory on Nov. 16, 1909.

ELECTRIC GANTRY CRANE, 105-FEET SPAN, PORT NATAL.

What is the position of the railway today? Nearly two-thirds of the whole line, from Cape Town in the south to the Congo border, and from Cairo in the north to a point nearly 200 miles south of Khartoum, are practically completed; and there is now not the smallest doubt that the intervening stretch will "get itself built" in due course. If the original idea of the route from the south is not being strictly adhered to, it does not matter a solitary dime, so long as the line advances. And this it is doing in spite of local difficulties, engi-



ROUND HOUSE, LOURENÇO MARQUES.

neering, international, or financial. When I "left" the line, a couple of years since in these pages, railhead was at Rhodesia Broken Hill, and there it remained for several years. In January last, however, a contract was entered into with Messrs. Pauling, the railway engineers, for an extension of the line to Bwana Mkubwa, on the Congo border, some 132 miles away, which point was reached on November 16 last.

TRAIN DE LUXE, RHODESIA RAILWAYS.

BENGUELLA: THE STARTING PLACE OF THE RAILWAY.

The same engineers are now busy on the other side of the border and expect to reach the next stage of the work—the Star of the Congo mine—early in October. Two bridges and two embankments are included in the recently completed section, the line running for miles through forests of native teak wood.

Early in December, Bwana Mkubwa was the scene of an interesting gathering of railway men and others, who assembled by special invitation to celebrate the passage of the first train across the Belgian frontier. Under a triumphal arch, gaily decorated with flags and situate in the heart of a forest, the last two fishplates (made of locally-smelted copper) were riveted on either rail by two of the leading men present, namely, Mr. Wallace, the Administrator of Northwestern Rhodesia, and Baron Wangerwee, the representative of the Congo. A few minutes later the special engine and train steamed across the border and pulled up into Belgian territory. At the banquet which followed, some interesting speeches were made, not the least so, being delivered by Mr. T. S. McEwen, general manager of the Cape Government Railways, who incidentally contrasted South African railways with the other systems of the world, maintaining that for comfort and catering they were equal to British railways, and only slightly, if at all, inferior to American.

As has been indicated, the intention is to carry the line to the highly-mineralised region known as the Star of the Congo, and probably thence onwards to a point near Kambove. Ultimately, it will meet the Benguella railway now advancing from Lobito Bay, in Portuguese West Africa, some details of which will be found in my article of two years ago. The most difficult part of the work, from Lobito Bay up to kilometre 216, was constructed by Griffiths & Co., Contractors, Ltd., and included a rock section and numerous bridges and other heavy work. The contract having been completed, the work

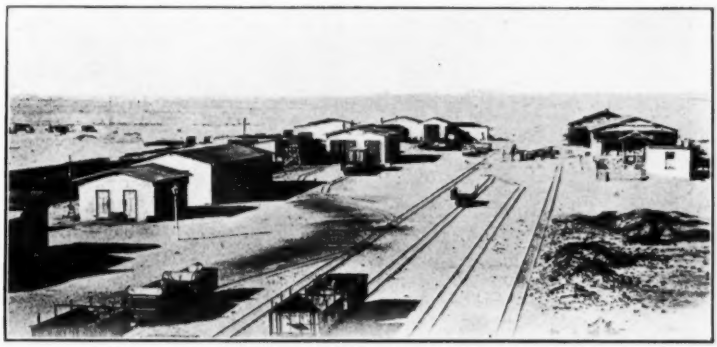
was put up for re-tender and the offer of Messrs. Pauling was accepted and the work is now being proceeded with. From Lobito Bay to the line's objective in the Katanga district is roughly about 900 miles, almost in a straight line, but the extension from kilometre 216 should be child's play to the engineer, seeing that the country between it and Katanga—so Mr. Norton Griffiths once told me—is as flat as a billiard table and presents no engineering difficulites.

CATUMBELLA BRIDGE, LOBITO BAY RAILWAY, PORTUGUESE WEST AFRICA.

Of course, the idea is to make the Benguella line pay its way section by section. "Once we reach kilometre 320," wrote an official of the company, "the earnings from the railway will be sufficient to pay the expenditure and leave enough for the debenture interest." Mr. Robert Williams, the moving spirit in the Lobito Bay-Katanga scheme

—has recently arranged with the Portuguese Government for favorable modifications in the original concessions whereby an extension of time has been given to build further sections of the line.

From what point or when the Cape-to-Cairo line will be extended northwards no man at the moment knoweth. Two years ago, I predicted that the other prong of the contemplated fork from Broken Hill to the north—that running through German territory alongside Lake Tanganyika—would be abandoned "for some years to come, at all events." Today, it looks as if that route is abandoned for all time. I do not say the Germans are to blame for that; but I do say that they



SWAKOPMUND, GERMAN SOUTHWEST AFRICA.

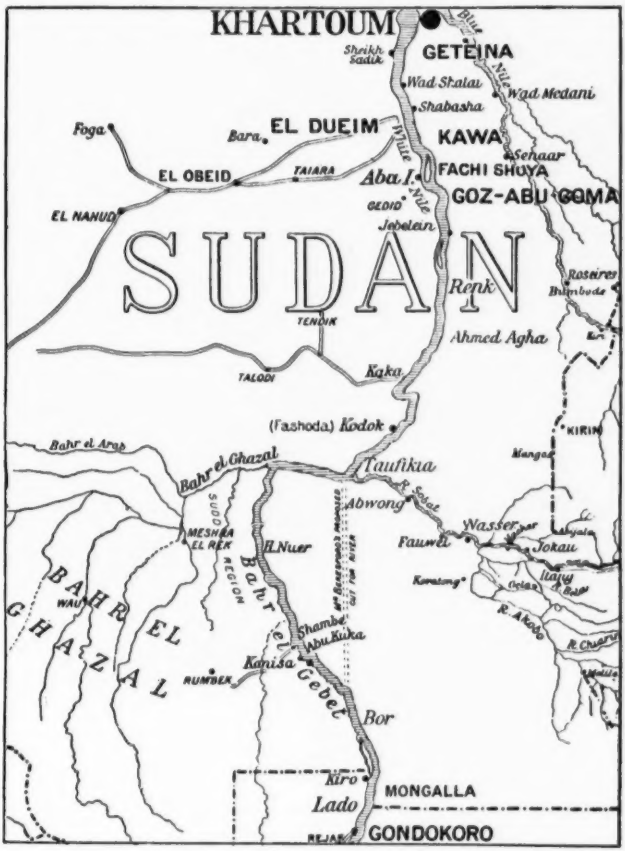
have never shown any particular enthusiasm for the Cape-to-Cairo scheme. Possibly, they think that with such a splendid waterway on hand there is no need to build a line alongside it in their territory, but that the Cape-Cairo railway should connect north and south with the lake. I certainly think that in time to come we shall see a line running from Broken Hill to the most southerly corner of Tanganyika, there to connect with a fleet of lake steamers, but at present there is no intention to carry the railway in that direction. The present tendency, as I have shown, is to carry it westwards, and the chances are that in time to come it will be united with the system known as the Great Lakes Railway, and thence be carried across country till it reaches Uganda or some point in Southern Sudan where it can be linked up with Khartoum and so carried on to Cairo.

Meanwhile, the railway is rapidly being pushed on south of Khartoum, a section of 120 miles, as far as Wad Medani—an important place on the Blue Nile—having been opened for traffic. Construction is still going on, at the rate, I understand, of a mile a day, the course

IN THE MABIRA FOREST, UGANDA.

of the line continuing some 50 miles further south along the Blue Nile and then turning westward across the Ghezireh to the White Nile at Kosti, where a fine new bridge is nearing completion to take it up to El Obeid in the Kordofan district. The section from Kosti to El Obeid will not, however, be on the Cape-to-Cairo route and through travellers will have to leave the rail at Kosti for the south by boat up the White Nile. In addition to the Blue Nile railway bridge another is in course of construction over the White Nile at Goz-Abu-Gowa, 192 miles south of Khartoum. Both these bridges are being

built, I understand, by the Cleveland Bridge Co., of Darlington, England, the firm responsible for the great bridge spanning the gorge of the Victoria Falls, in Rhodesia.




SKETCH MAP OF THE SOUTHERN SUDAN.

I have referred to Uganda, which is likely to play a not unimportant part in the distant development of the Cape-to-Cairo scheme. Up to the present, however, Uganda itself is innocent of railways—the well-known line which bears its name being, of course, in the adjacent territory of British East Africa—unless one can call three miles of mono-rail, which is now being experimented upon, near Kampala, a railway. Schemes are projected for the construction of a

OBUASSI STATION, BRITISH WEST AFRICA.

line in Uganda which will probably be worked as part of the Uganda railway or in conjunction with it. Another proposed line is intended to go from Kampala to the Congo border, and—who knows?—perhaps this is destined to be the connecting link of the trunk line the southern railhead of which is, for the time being, at Bwana Mkubwa.

Of the Uganda Railway, so-called, but little need be added to what I have said about it in previous articles. It has reached the paying stage, even if the returns for the year ended March 31, 1909, showed but a very slight improvement over the preceding twelve months. Extensions from the main line are either in being or are contemplated, and in the latter category may be placed the line which is to open up the great natural soda deposit known as Lake Magadi. This branch is to be constructed and worked by the Government, and will be of the same pattern as the Uganda Railway, of which it will form a part. The route was lately surveyed by Mr. Fred. Shelford, the well-known engineer, and the country traversed proved to be extremely difficult, the route being continually crossed by escarpments, eight to ten miles long, and 300 to 400 feet high. Lions were constantly met with en route and at one camp an infuriated rhino deliberately charged a tank containing the only supply of water.

On the other side of the continent both in British and French territory, a good deal of activity in railway circles has to be chronicled. Two years ago in THE ENGINEERING MAGAZINE I gave some account of what the British proposed to do in opening up Nigeria and how a line of 3 feet 6 inches gauge and 400 miles in length was to connect Baro on the River Niger, with Zangera and Kano, and, ultimately, Kano with the coast port of Lagos. Excellent progress has been made with the two sections of the line and it is expected that by September next through communication will be established between Lagos and Kano. The section from Lagos to Jebba was completed in April last. Opposite to Jebba the River Niger flows in two branches enclosing a small island, and eventually the river will be crossed at this point by two large bridges. To the north of this the line is being continued to the Kaduna river and thence along the course of a steam tramway—built by the former High Commissioner, Sir F. Lagard—to Zangera. From Zangera a connection will be established with the Baro-Kano line and thus on the completion of the latter section (possibly during the coming year) one will be able to travel from Kano

OROUGOO BRIDGE NEAR FREETOWN, SIERRA LEONE.

ABOVE, A TYPICAL LOW VELDT STATION IN THE TRANSVAAL. BELOW, ON THE LINE OF THE SWAZIELAND RAILWAY.

DWELLING HOUSE UNDER CONSTRUCTION AT STANLEYVILLE, CONGO FREE STATE.

ONE OF THE BRIDGES ON THE STANLEYVILLE RAILWAY, UNDER CONSTRUCTION.
These are features of the Great Lakes Railway project.

ON THE NILE.

either all the way by train to the coast at Lagos, or by train to Baro and thence by river steamer to the mouth of the Niger.

Elsewhere, other lines are being constructed which, although perhaps of a minor character, are yet of considerable local importance and have a direct bearing on the African railway scheme as a whole. This article has already run to such length that I can only give these barest mention. Thus, in the sub-continent, the much-needed line which is to connect Cape Colony and Natal is at last nearing completion, and in the latter colony there is an accumulation of railway work to be carried through, including the line into Zululand. Several new lines are to be built in Orange River Colony, one of which will open up a new route to Basutoland and tap some very rich farming country. Some notable extensions are in progress in the Transvaal; and in Rhodesia a start is to be made this year with the first section of the line between Majol and Abercorn. It remains to be seen what effect the forthcoming Union of South Africa will have on local railway projects.

In German, French and Portuguese Africa many important projects are contemplated, not the least of these being that between Inhambane and Inharrime, in Portugal's south-east territory. Railway activity is also reported in the vicinity of the Great Lakes Railway, in the Congo region; and in Egypt the railway engineers are busy in more than one direction. In no other part of the world, perhaps, is railway construction so much to the fore as in Africa, and the amount of material now being poured into that country from all parts of the world must be enormous. And the glad fact, from the engineering point of view, remains that only the fringe of railway development has yet been touched, and that for many years to come there will be an increasing and vigorous demand for electrical power and mining machinery and the whole range of mechanical equipment and supplies.

# COMPENSATION OF WORKMEN AND EFFICIENCY OF OPERATION.

*By H. L. Gantt.*

## III. TASK AND BONUS.

Mr. Gantt's series, which is attracting widespread and close attention from employers and managers of labor, began in our issue for February last. Preceding parts have considered the efficiency of workers as influenced by mode of management and compensation under the day-work and piece-work systems, respectively. The fourth part, which will follow in May, will show in detail, by the aid of most interesting colored charts, what has been accomplished by Mr. Gantt's system in various occupations and in a large number of individual cases.—THE EDITORS.

IN the previous articles an attempt was made to show that present labor conditions—that is, labor unions and employers' associations—are a natural and almost a necessary result of the present methods of handling workmen. The horizontal wage, under which men in a certain class get a certain wage and under which it is practically impossible for any individual to get much more than the average day, or piece-work, wage of the class, has its effect in causing the workmen of that class to combine to get the average wage of the class increased.

It was also explained that as long as we classified workmen and paid those of one class substantially one wage, without greatly varying that wage according to efficiency, the efficient men, realizing that they could not get any more money than was paid to the average of their class, would continue to combine with the others in that class to have the class wage raised. This is what they have done in the past; and, if we read human nature aright, this is what they will do in the future, until some means has been devised by which the efficient man can get proper compensation for his work. When his compensation is independent of what the inefficient man gets, he will not worry himself greatly about combining with the inefficient man. The employer recognizes that the efficient man is worth more to him than the inefficient man, but most employers do not know any scheme by which they can compensate the efficient man according to his deserts, and avoid trouble with the inefficient man.

The object of this article is to show what we have accomplished both in the way of rewarding the efficient man, and of making the inefficient man efficient.

In 1899 I was offered a position with the Bethlehem Steel Company to assist in putting into operation methods for increasing the efficiency of their labor. This work was being done by Mr. F. W. Taylor, with whom I had been associated twelve years previously in the Midvale Steel Company, where the methods underlying Mr. Taylor's work had originated, and where they are still in operation.

One object that Mr. Taylor had in mind was to establish throughout the plant a system of piece work based on a scientific study of what could be done, and to make piece rates that should be permanent. The portion of the works that seemed to offer the greatest field was the main machine shop; but before setting these piece rates it was necessary to make a great many changes. Machines in this shop had been located, not with reference to any particular system of management (because nobody had given the system of management any particular thought) but promiscuously, throughout the shop.

In order to do work economically it was desirable to rearrange the machine tools in such a manner that a foreman, expert on one class of work, should be able to supervise that work. Accordingly the location of the machines was so changed as to place the large lathes in one group, the small lathes in another, the planers in another, etc. While the machines were being moved they were re-speeded to enable them to utilize to advantage the improvements that had been made in tool steel, Mr. Taylor at the same time making a large number of experiments* to determine the best shapes of tools and the best tool steel with which to do the work, which in this shop was very miscellaneous in character. Even when we got the shop rearranged, much study still had to be done before we could know enough about the conditions to make permanent piece rates.

The high degree of perfection demanded by Mr. Taylor took much time; and the consequence was, that although slide rules for determining how to do machine work and instruction cards for directing the workmen had been in use since May, 1899, the monthly output of the shop during the year from March 1, 1900, to March 1, 1901, had been but little more than the monthly average for the five years preceding.

Up to this time we had devoted ourselves to the study of what could be done, and had done but little to cause the workmen to co-operate with us. This record shows that we had not in any measura-

*The result of these experiments was the development of the Taylor-White method of treating tool steel.

ble degree secured their co-operation. In other words, we had much knowledge, but were unable to get any substantial benefit from it because the men would not help. Not being ready to introduce the differential piece-rate system, which was regarded as the ideal one for obtaining a maximum output, I felt that we should not wait for perfection, but should offer the workmen additional pay in some manner that would not interfere with the ultimate adoption of the differential* piece-rate system. Accordingly on March 11, 1900, I suggested that we pay a bonus of 50 cents to each workman who did in any day all the work called for on his instruction cards. This was adopted at once, and Mr. E. P. Earle, the superintendent of the machine shop, suggested that we should also pay the gang boss (man who supplied the work) or speed boss (foreman) a bonus each day for each of his men that earned his bonus. This was also approved, and both plans were ordered to be put into execution as promptly as possible.

This bonus payment was begun at once, and on May 13 the assistant superintendent of the machine shop, Mr. R. J. Snyder, made the following report:

Mr. E. P. Earle,
Supt. of Machine Shop No. 2.

*Dear Sir*:

I hand you herewith some notes on the results obtained by the introduction of the "bonus" plan for remunerating labor in No. 2 machine shop. (Here follow machine numbers and dates when they were started on this plan.)

One of the best results after a short trial has been the moral effect upon the men. They have had it placed in their power to earn a very substantial increase in wages by a corresponding increase in their productive capacity, and this has given them the feeling that the company is quite willing to reward the increased effort. They display a willingness to work right up to their capacity, with the knowledge that they are not given impossibilities to perform. This effect has been brought about by the good use of our excellent slide rules in the hands of a number of the most thoroughly practical men, who, when the results which they demand have been declared impossible to obtain, have repeatedly gone out into the shop and themselves demonstrated that the time was ample, by doing the work well within the limits set. All this has inspired the confidence of the shop hands, and the excellent instruction cards sent out are gradually evolving from laborers a most efficient lot of machine hands. . . . The percentage of errors in machining has been very materially reduced, which is unquestionably due to the fact that in order to earn his bonus a man must utilize his brains and faculties to the fullest extent, and so has his

*The differential piece rate was devised by Mr. F. W. Taylor while with the Midvale Steel Co. to stimulate maximum production. It consisted of a high rate per piece if a definite large product per day was attained, and a lower piece price if the output was less than the amount set. The effect of the system was to cause a big increase in wages for attaining a definite degree of efficiency.

attention closely fixed on the work before him, as every move must be made to count. He thus has no time for dreaming, which was, no doubt, the cause of many errors.

The condition of the machines is vastly improved. Most care has been taken to point out to the men that the best results can be obtained only by keeping their machines in good running condition, well lubricated and cleaned. They have not been slow to realize this, and cases of journals cutting fast are very rare, while before the introduction of the "bonus" plan this was a very common occurrence. Breakdowns are also of a less frequent occurrence.

The crane service lately has given us little trouble, and lack of crane service was formerly a constant excuse of the bosses and men for not being able to keep machines filled with work. The improvement in this case arose from the rule laid down that no exceptions or allowances would be made for delays due to this cause.

It is only by the introduction of this "bonus" plan that we have had furnished the automatic incentive for men to work up to their capacity and to obtain from the machines the product which they are capable of turning out. It has lifted the hands of the speed bosses (foremen) and enabled them to act in the capacity for which those positions were created —that of instructors.

These are some of the direct results obtained. Indirectly it has eliminated the constant necessity for driving the men, and has enabled the shop management to divert some of its energy into perfecting the organization, which only will enable us to give a good account of the shop equipment. Much good has also resulted from putting the work through in lots, and keeping each machine as nearly as possible on the same kind of work.

It is also a pleasure to note in this connection the deep interest taken in the work by the men connected with it, and the fine co-operative spirit which prevails among all hands.

This report was made only two months after the bonus system was started, now nearly nine years ago, and is particularly valuable as it emphasizes some of the fundamental principles on which successful work of this character must be founded. We must secure the confidence and co-operation of the workman by assuring him equitable compensation. If we fail to do this, any results we may get will be of short duration and our work will finally come to naught. Many of the failures to get continuously the high efficiency which seemed easily possible, have been due to a disregard of the fact that the workman is entitled to a share in the benefits of increased efficiency, and in the long run will not co-operate unless he gets it.

The attempt to drive the workman to increased efforts which benefit the employer alone, necessarily creates a force of opposition which grows greater as it is carried farther. Finally, the force of opposition becomes so great that further progress is impossible and the system of management based on *force* breaks down. This is as it should be,

if we are to progress from an era of force to one of equity, and to make obsolete the doctrine that "they should take who have the power and they should keep who can." Continual failure to obtain our ends permanently by force, and success in obtaining them by co-operation, will ultimately show that the selfishness that prompts the use of force is unintelligent, and that the most intelligent selfishness is that which shares the benefits equitably among those helping to obtain them.

In closing the discussion on a paper on training workmen, read before the American Society of Mechanical Engineers, December, 1908, I made the following statement:

> A system of management may be defined as a means of causing men to co-operate with each other for a common end. If this co-operation is maintained by force, the system is in a state of unstable equilibrium, and will go to pieces if the strong hand is removed. Co-operation in which the bond is mutual interest in the success of work done by intelligent and honest methods produces a state of equilibrium which is stable and needs no outside support.

In the paper itself the following statements are found:

> The general policy of the past has been to drive, but the era of force must give way to that of knowledge, and the policy of the future will be to teach and to lead, to the advantage of all concerned.
>
> It is too much to hope, however, that the methods about to be described will be adopted extensively in the near future; for the great majority of managers, whose success is based mainly on their personal ability, will hesitate before adopting what seems to them the slower and less forceful policy of studying problems and training workmen; but should they do so they will have absolutely no desire to return to their former methods.

In some quarters I have been regarded as not making the most of opportunities because of adherence to this policy, but results in the long run have been so much greater and more stable than those obtained by the driving method, that even the strongest advocates of force are beginning to recognize that in their desire *to get great results quickly they may fail to get them permanently.*

To go back, however, to the Bethlehem Steel Works, we note that the average monthly output of the shop from March 1, 1900, to March 1, 1901, was 1,173,000 pounds; and from March 1, 1901, to August 1, 1901, it was 2,069,000 pounds. The shop had 700 men in it and we were paying only about 80 men on the bonus plan out of that 700. I left the employ of the company in September, 1901, but the number of bonus workers increased for some time, although an unintelligent selfishness on the part of the management soon caused them to cease paying any bonus to the foreman. Other changes

gradually followed, until in a few years the essential principles of this work were practically eliminated and the efficiency of the shop ran down to such an extent as to become notorious. A complete return to the *drive method* after repudiating these principles, has produced a series of labor troubles, which, at this writing, have culminated in closing down the whole plant.

*Contrast this with over thirty years' freedom from labor troubles enjoyed by the Midvale Steel Company, where long ago these methods had their beginning.*

The plan as started at Bethlehem of paying a fixed bonus for performing the task had one element of weakness, namely, that after the men had earned their bonus there was no further incentive to them. It was some time before I devised a satisfactory method for adding such an incentive, which was finally accomplished by paying the workman for the time allowed *plus a percentage of that time.*

For instance, if the time allowed for a task is three hours, the workman who performs it in three hours or less is given four hours' pay. He thus has an incentive to do as much work as possible. If the workman fails to perform the task within the time limit he gets his day rate. The time allowed plus the bonus is the equivalent of a piece-rate; hence we have piece work for the skilled and day work for the unskilled.

One other feature of this work at Bethlehem had a most important effect on the result—namely, that in addition to the bonus paid the foreman for each man under him who made bonus, a further bonus was paid if *all* made bonus. For instance, a foreman having ten men under him would get 10 cents each, or 90 cents total, if nine of his men made bonus; but 15 cents each, or $1.50 total, if all ten made bonus. The additional 60 cents for bringing the inferior workmen up to the standard made him devote his energies to those of his men who most needed them.

*This is the first recorded attempt to make it to the financial interest of the foreman to teach the individual worker, and the importance of it cannot be over-estimated, for it changes the foreman from a driver of his men to their friend and helper.*

Under former conditions, the foreman hesitated to teach the workman for fear the latter might learn as much as he knew and possibly get his job. Under the new conditions, the man who knows is paid for teaching others as much as he knows, and the others are paid a bonus for learing and doing what they are taught. It is this feature of the task and bonus system that has enabled us not only to obtain, but to maintain permanently, such satisfactory results. The expert

workman who becomes a good teacher soon makes his services valuable, for, by his assistance, *we can often make the average efficiency of the shop even greater than his best efficiency was before we began to study the question of efficiency. He learns to remove obstacles which stood in his way when he was a simple workman, and often becomes an expert also not only at removing these obstacles, but of developing better methods to avoid them.*

Such, in brief, is the history of the development of the task and bonus system, which, starting as a substitute for differential piece work, gradually supplanted it, differing only by the fact that the worker who failed to earn the high rate got his day's pay instead of a lower piece rate, thus allowing the inefficient workman a chance to earn a living while learning to become efficient. This effort to help the poor workman by giving him a living wage and an instructor, enables us to utilize many bright young men who either did not have a chance to learn a trade, or did not appreciate it when they had it. This is an exceedingly large class, and one that we find everywhere.

To review again the elements on which this system is founded, we note:

1.—A scientific investigation in detail of each piece of work, and the determination of the best method and the shortest time in which the work can be done.

2.—A teacher capable of teaching the best method and shortest time.

3.—Reward for both teacher and pupil when the latter is successful.

Are not these elements sure to make for success? The fact that we have been able to develop promptly workmen who could satisfactorily perform any ordinary task is the best answer. This method of providing workers for the semi-skilled jobs of a factory has been so successful that we are led to ask whether our method is not the basis on which to found a system of instruction and training for apprentices and workmen in general.

In the next article we shall show in detail what has been accomplished, and give data which prove that money invested in establishing a scheme of management and training on these lines yields a very large return.

One of the best results of this work is that the trained workmen almost always hold on to their jobs, and the few that leave soon come back. This will be most clearly demonstrated in our next article, in which it will be shown that under our methods workmen take pride in being efficient.

# A GENERAL REVIEW OF HYDROELECTRIC-ENGINEERING PRACTICE.

*By Frank Koester.*

In the series of which this is the first part, Mr. Koester's purpose is not to instruct the specialist in hydro-electric engineering. It is to provide a clear and concise statement of the fundamentals of established practice in this field for the use of others who may be interested, either as practitioners in other provinces of engineering, as owners or managers of power-using installations that may be electrically operated, as providers or purchasers of machinery for some part of the equipment, or as commercial or financial participants in some development involving the utilization of water power.—THE EDITORS.

PRACTICALLY all civilized countries today lay great stress on the utilization of their water-powers, and especially during the past few years various governments have taken more or less active interest in securing equal benefits to all from such natural resources. What only a few years ago by many was deemed of little importance, is today one of the greatest problems with which the engineering profession has to cope.

The latest government reports show that the total development in the United States represents 5,356,680 horse power, the number of wheels being 52,827, or an average development per wheel of about 100 horse power. The State of New York possesses the largest water-power development, the total being 885,862 horse power. It is only proper to state that the Niagara powers on the American side assist in making up this large total. The State ranking second in these developments is California, the total being 466,774 horse power distributed among 1,070 wheels, or an average installation per unit of 436 horse power. The third in rank is Maine with a total development of 343,096 horse power, generated by 2,797 wheels, averaging 123 horse power.

The reports show further that the total available power of the surveyed portions, including storage possibilities, is about 53,000,000 horse power, and as only about one-fourth the total area of the United States is now surveyed, the available power for the whole United States may reach at least 200,000,000 horse power and probably more.

The following table enumerates the water powers that can be developed in eight European countries on the basis of quantities of water per second available during nine months, according to the latest reports:

| | Total H. P. | H. P. per Sq. Km. | H. P. per 1000 Inhabitants. |
|---|---|---|---|
| Great Britain | 963,000 | 3.06 | 23.1 |
| Germany | 1,425,900 | 2.6 | 24.5 |
| Switzerland | 1,500,000 | 36.6 | 454.5 |
| Italy | 5,500,000 | 19.0 | 169. |
| France | 5,857,000 | 10.9 | 150. |
| Austro-Hungary | 6,460,000 | 9.6 | 138. |
| Sweden | 6,750,000 | 15.0 | 1290. |
| Norway | 7,500,000 | 20.0 | 3409. |

NOTE: One square kilometre equals 0.386 square miles.

Switzerland has the largest water power available per square kilometre, but Norway has by far the largest available water-power per 1,000 inhabitants, and has 5.36 times the available power possessed by Germany. On the other hand, the present commercial value of water power of Germany is by no means in the same ratio to the water powers of Norway, because Germany will be able to find use for all its available water power in the near future while Norway, at present, could utilize only about 10 per cent of its available power.

However, close observation of all facts pertaining to water power developed would indicate that the countries which are foremost in hydroelectric development are the United States, Canada, Switzerland, Italy, Sweden and Norway. The next group of countries, in which the water power resources are more limited, covers France, Germany, Austria, and Great Britain. In the next group we may put those countries which have great water-power resources but comparatively few developments, being Mexico, South America, Australia, Japan, and South Africa. The fourth group embraces such countries as have done very little in the development of these natural resources, viz., Russia, Spain, Greece and India.

America is the land of unlimited possibilities and rich in natural resources of all kinds, including water power, and as American engineers always strive to produce engineering work on a record-breaking scale, the United States naturally leads all countries in large water-power developments. Great financial resources being at hand, it is possible to secure great results in a very limited space of time; and this is done in order to place the proposition on a paying basis as quickly as possible, and frequently regardless of real economy. The sacrifice is due to the fact that the engineer does not take the time to ponder over the many small details through which the economical operation of a plant is secured and interruption of service are prevented. In fact, it is quite common practice to overhaul and improve such plants after a few years in order to place them on an economical operating basis, particularly when forced by competition. Our hydroelectric developments are often examples of our national wastefulness.

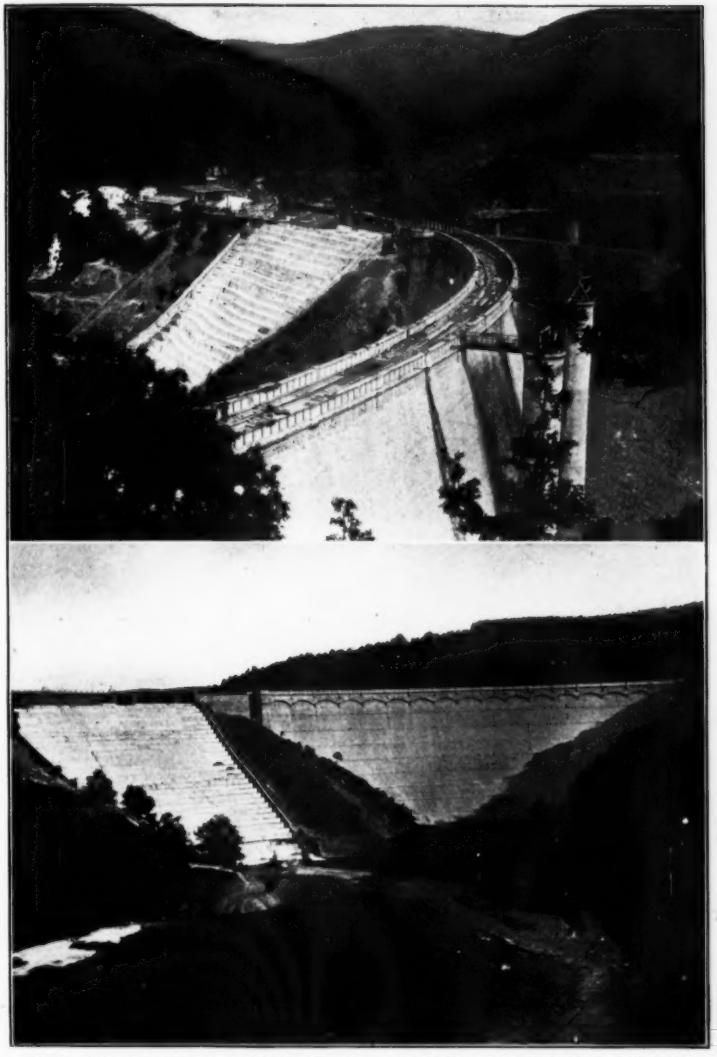
In contradiction to this practice, that of Continental Europe, limited in its water-power and financial resources, is to give such engineering undertakings a thorough preliminary study and to pay careful consideration to the many details upon which refinement in economy and reliability of operation depend. This applies not only to the transformation of water power into electrical energy, but also to the transmission and distribution of current, and we find here also that American engineers are boldest in their undertakings.

If we wish to find originality of scheme and novelty in design, we must generally look elsewhere; and in the following treatise an effort is made to discuss the latest American and European practice, from the viewpoint of a broad and extended experience both in the United States and in Europe.

In connection with the development of water powers much preliminary study is necessary, as to drainage area, the advantageous location of plant, and especially the market for current, upon which depends the commercial success of the undertaking. Reliable data must be collected in order to put the proposition in definite form to submit to the capitalists. Although the public, year after year, is made more familiar with the financial worth of hydroelectric developments, it is one of the most difficult of propositions for the engineer or promoter to arouse public interest, and particularly the interest of the capitalist, in undertakings of this kind.

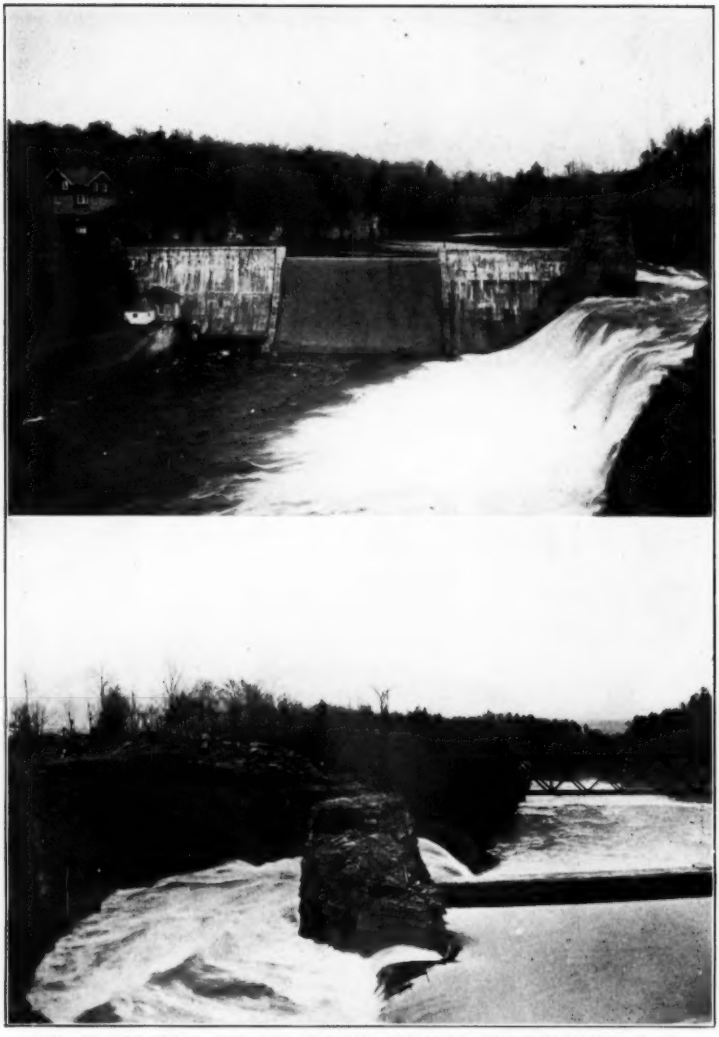
In the "harnessing" of water in connection with hydroelectric developments, we may recognize two systems, that of impounding the river, and that of deflecting the flow of the river. Developments of the former kind were formerly used principally for irrigation, navigation, protection against floods and city water-supply purposes. In recent years, however, this system has also been adopted for power purposes and we find, particularly on the continent of Europe, two or more of the above propositions are simultaneously carried out as one scheme which offers the most economical plan for the utilization of water. That such a combination requires many-sided and far-sighted preliminary study is without question. The utilization of mountain lakes bears a relation to this system, requiring, however, no artificial dam, as the water is already retained in the collecting basin without impounding; the lake is either tapped at the bottom, or, according to new Swiss practice, the water as needed is siphoned out.

The other system is that in which the flow of water is deflected by a dam built either across the river, or at an angle and partly across it.



TWO VIEWS OF THE URFTTALSPERRE DAM, A TYPICAL CONTINENTAL STRUCTURE.

Whatever system may be employed, the forests of the drainage area bear a most important relation to the successful development. It is a well-known fact that the soil of forests retains the water of



DAM OF THE UTICA GAS AND ELECTRIC COMPANY, TRENTON FALLS, N. Y.

precipitation uniformly and releases it gradually so that a supply of water is assured during the dry season. Flat land without trees may hold the water in swamps, but in most cases it is drained away rapidly, so that streams having denuded watersheds are subject to either floods

or droughts. Observations prove that forests receive a greater precipitation than bare lands in the same vicinity, and also that mountainous land, whether bare or covered with forests, receives more precipitation than flat country at the same altitude. Furthermore, the factor of evaporation in forest lands is 25 per cent less than for bare land. The advantage of forests in connection with hydroelectric developments may be best seen from the observations made in Switzerland, showing that before the destruction of certain forests a flood occurred at an average period of 54 months, whereas after the destruction the flood period averaged 29 months.

In the majority of cases reports on the drainage areas covering precipitation, flow, etc., may be had from the government reports. They should not, however, be accepted without reserve, but investigation should be made on the spot to confirm the reports and to secure further data. The method of measuring the flow by means of the miner's inch as originally and extensively carried on in California is now obsolete. The use of the weir dam may be satisfactory for a small flow, but when the flow of large rivers is to be measured modern and more scientific methods must be adopted, such as the current meter. It is necessary to establish observation stations on the main stream and its tributaries. The records of levels must cover a period of several years, readings being made every day and twice per day or oftener during flood seasons in order to establish fair average results.

These results must be properly plotted, as also the profile of the river and other data in connection with the general survey, in order to secure a proper oversight as to the flow and to determine the best location for the power house.

The first cost, efficiency, and economy of a hydroelectric development, depend to a large extent upon the ability of the designer. It should be the ultimate aim of the engineer to produce and distribute electrical current at a minimum cost. It is not the province of the designing engineer of a hydroelectric plant to design any particular machines, such as turbines, generators, oil switches, etc., but to provide a selection of various makes, each designed to perform its functions in the most economical manner; and to have these machines in proper combination to form one complete unit for the purpose of generating electrical current from water power on a commercially satisfactory basis. Great care must be exercised on the part of the designer, for instance in selecting turbines suitable to the head; a turbine designed for a low head would not be efficient if used with a high head. It is just in this connection that mistakes in selection have been exceptionally frequent in American practice, thereby materially

cutting down the efficiency of the turbine and simultaneously the economy of the plant.

The work embodied in a complete hydroelectric undertaking embraces hydraulic, structural, mechanical, and electrical engineering, yet in order to secure harmonious co-operation, it is essential that the whole undertaking should be directed by one head. As most developments, particularly those of great magnitude, are far distant from the engineering organization and, as in many instances, the original plans cannot always be strictly adhered to, the resident engineer

TIMBER DAM, CAZADERO, PLANT OF THE PORTLAND RAILWAY & POWER COMPANY, PORTLAND, OREGON.
A type once common in America.

should be a thoroughly capable man and should have sufficient authority to make necessary changes, which though trivial in themselves may seriously affect the remainder of the plant. Of course all such changes undertaken must be promptly reported to headquarters, that they may be noted and the original plans properly amended.

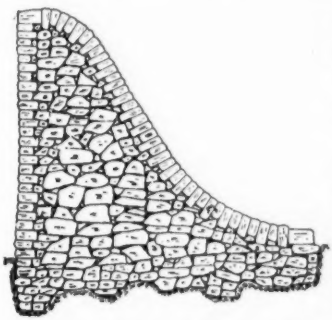
## Dams.

Of the many kinds of dams in use for hydroelectric installations the masonry dam is the most common. It is either of the gravity or arch type. The stability of a gravity dam depends upon its own weight, while that of the arch-type dam depends upon a trussed action at its ends which rest against mountain sides. A combination of these two principles is, of course, often found in one dam.

All gravity dams must rest upon solid foundations, and where these do not already exist an artificial one must be created, preferably by driving piles which may be wooden, concrete, or sheet-steel. In case there exists a rock bed it must be cleared of all earth and loose boulders, and some offsets (preferably in the form of trenches) must be made to prevent sliding. The bottom of the dam, in all cases, should extend at least five to six feet below the river bed, so as to prevent leakage of water under the dam, which has been the cause of many failures of solid masonry dams. Where treacherous ground is found sheet piling should be driven to a proper depth to prevent such underflow. Of course, before the location and the type of dam are decided upon soundings must be properly made to ascertain the condition of the bed as well as the underlying strata. In case of high dams where a great volume of water is impounded, the tests must also be made upstream and above the dam in order to prevent seepage due to the greater hydrostatic head. This is a factor which has evidently been overlooked in many installations. While records of the annual rainfall and evaporation as well as computations of the consumption of water are at hand, the loss of water usually cannot be accounted for. The remedy after completion of the work, when the water has already been impounded, is a costly one, and may consist in applying a layer of concrete over the entire surface of the bed of the pond.

In the selection of a site for solid masonry dams, particularly when they are of large size, the proximity of a stone quarry should be taken into consideration.

The majority of masonry dams are made of solid concrete or of cyclopean masonry. The mixture of the concrete dam is 1:3:6 or 1:4:8. However, coarser mixtures are also used, known as rubble concrete. Where large dams are to be built, cyclopean masonry is given the preference, the stone varying in size from cobble stones to sizes of one to two tons. The stones are so placed that the smaller stones fill up the spaces between the larger ones, the whole being imbedded in concrete mortar. Such dams must be properly faced, rough-faced stone sometimes answering the purpose, and in order to make these as well as all types of masonry dams watertight, the upstream



CROSS-SECTION OF CYCLOPEAN DAM, HUDSON RIVER ELECTRIC POWER CO.

DAM AND SPILLWAY, PLANT OF THE GREAT NORTHERN POWER COMPANY, DULUTH, MINN.

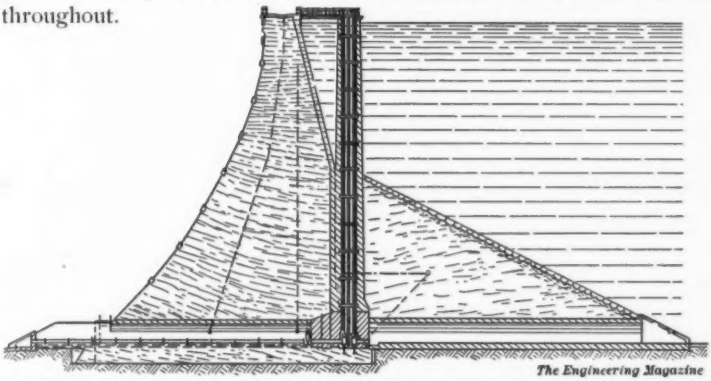
side of the dam must be faced with a mixture of rich cement mortar or a course of finer concrete. Where the dam is used as a spillway the downstream face must be made to conform to the curve taken by the overflowing water, and in order to prevent erosion the toe must also be curved to form an ogee, which at the same time serves to prevent the forming of a vacuum by the overflowing water.

An example of a good dam is shown in the illustration on page 31 representing the cyclopean masonry spillway dam of the Hudson River Electric Power Company at Spiers Falls, New York.

A unique dam, varying in many respects from American practice is that of the "Urfttalsperre" plant in Germany, herewith represented, and as it contains many notable features a short description of the construction may be of interest.

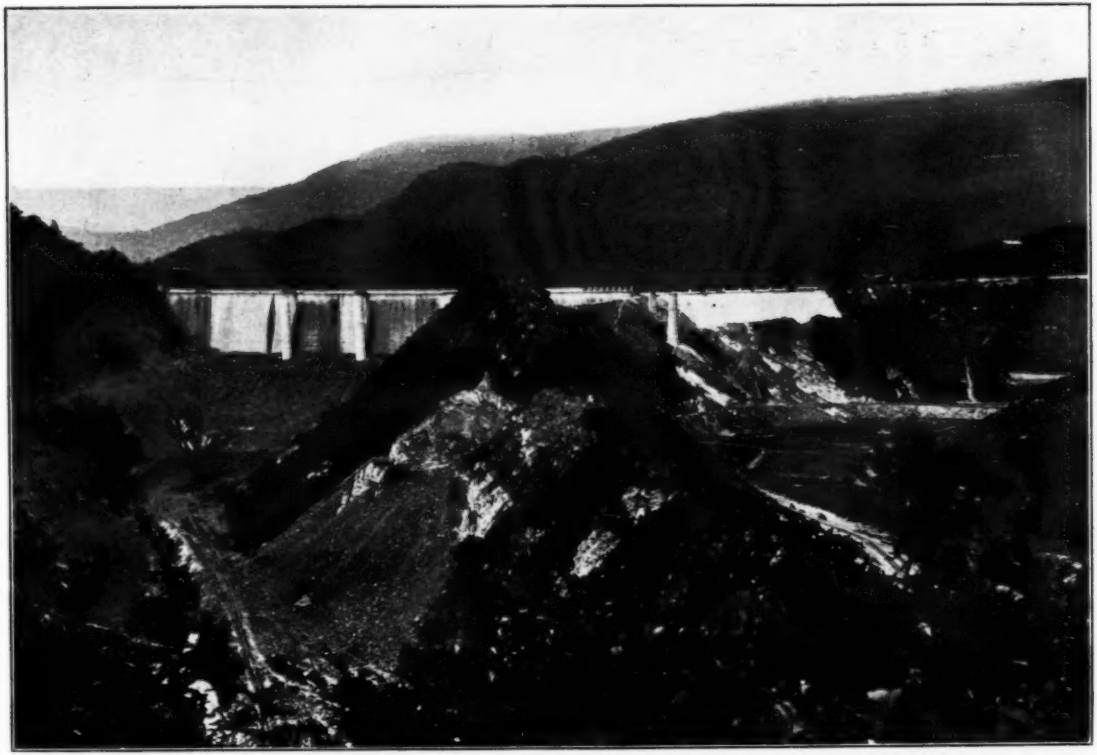
The dam is 190 feet high, having a width of 165 feet at the bottom and 17 feet at the top. It is built in arch form with a radius of 500 feet, giving the crown a

total length of about 1,000 feet, 300 feet of which is used for spillway; the water flows over in cascades. The dam itself is constructed of cyclopean masonry, the largest of the stones being of a size which requires two men in handling. It is built in one continuous mass, for which purpose three timber towers were erected for elevating material. From these tracks lead across the dam and by means of turntables cars were placed on longitudinal tracks. The mortar is composed of lime, sand, and trass. Cement was not used because it was feared that the cement would harden too quickly and unequally throughout the mass, thus producing unequal stresses, which usually causes the cracks in dams. This trass, a volcanic material, also used in making earthenware, was used by the Romans, and some underground Roman works were found in this locality in the construction of which this material had been used. These were found to be in an exceptionally good condition and its use was therefore adopted for this dam as well as for other German dams built in late years. Trass, mixed with lime and sand, forms a hard and impervious substance which dries slowly and equally throughout.




SECTION OF URFTTALSPERRE DAM, SHOWING VALVE CHAMBER FOR EMPTYING THE RESERVOIR.

The downstream side of the dam is faced with rough-faced cut stone. The upstream side is plastered with "siderosthen," a waterproof material, then faced with tile. The dam is provided with vertical seepage pipes erected in sections which are imperfectly jointed so that the seepage water may enter the pipe at each joint. For the purpose of emptying the storage basin two discharge pipes lead through tunnels through the bottom of the dam. The gates are located on the upstream side, in valve chambers, at the bottom of two shafts which extend above high-water level. The tops of the shafts

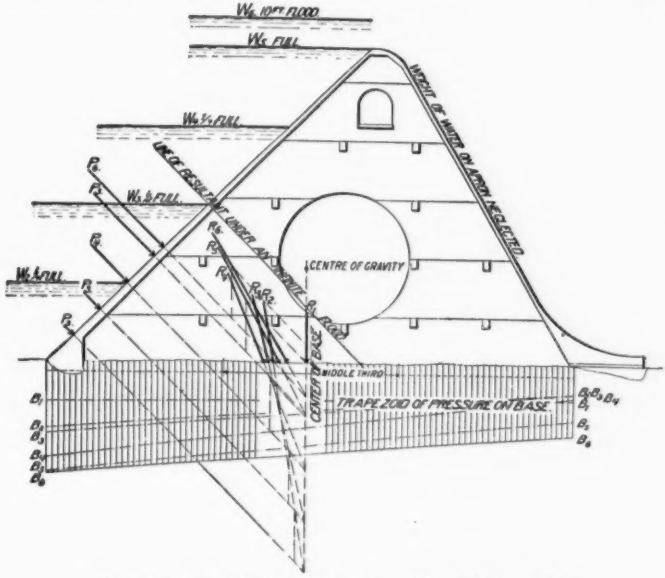


URFTTALSPERRE DAM, UPSTREAM SIDE, SHOWING PART OF THE EARTH FILLING AGAINST THE DAM.

and the crown of the dam, which serves as a roadway, are connected by bridges to permit access to the valves.

The water supply to the power house is not led from the dam through penstacks but is conducted through pressure tunnels leading through solid rock, which subject will be reverted to later.

Another feature, usually not found in connection with masonry dams, is the filling in on the upstream side of the dam, to about half its height, with earth, the top of which fill has a slope of 30 degrees to the horizontal and is paved with stone. This filling gives additional security both as to stability and as against underwashing.

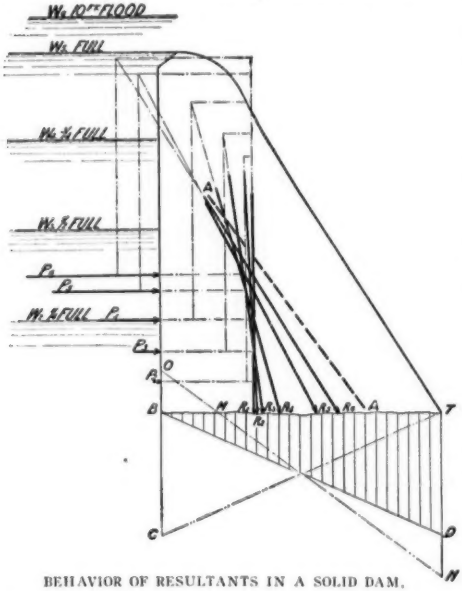



BEHAVIOR OF RESULTANTS IN A CONCRETE-STEEL DAM.

In the last five or six years reinforced-concrete dams have been much in favor for hydroelectric developments, and they display striking features of the adaptability of reinforced concrete.

The principle to be observed in the design of this type of dam is that the water pressure on the dam pins it down, consequently the upstream side of the dam, like that of timber dams, must have a long slope, whereas in solid-masonry gravity dams the pressure is exerted horizontally (provided the upstream side is vertical) tending to overturn the dam, which must therefore be made sufficiently massive by its own weight. The pressure exerted on the foundation of a gravity

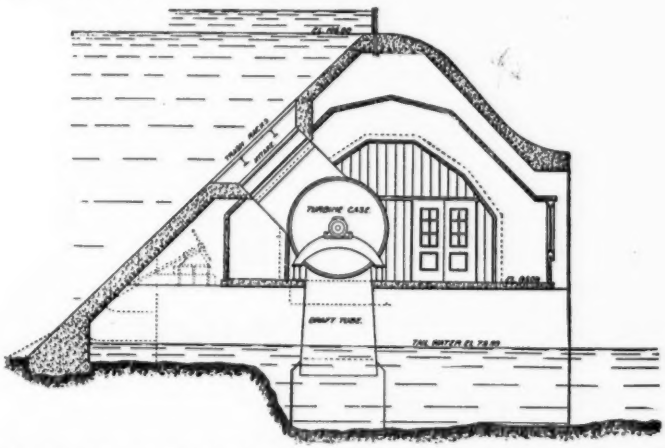
dam varies, theoretically, from zero at the upstream edge to a maximum at the downstream edge. The maximum must never exceed the crushing strength of the material; and usually a factor of 1.5 to 2 is employed. The slope of the "deck" of a reinforced-concrete dam may be so related to the weight and width that the pressure on the foundation is controlled by the will of the designer.




BEHAVIOR OF RESULTANTS IN A SOLID DAM.

Usually the proportions are such that the diagram of pressure is nearly a rectangle; i. e., the pressure is kept substantially uniform over the whole foundation, and with the excess pressure, if any, thrown slightly toward the upstream angle instead of being concentrated at the downstream edge. This arises from the fact that the resultant of the water pressure and weight of the dam can be held at, or a little above, the centre of the base, instead of passing down to the lower edge of the middle third. The movements of this resultant and the base pressure dependent thereon may be followed in the diagram, page 35, in which the resultant, as the dam fills, is seen to advance slightly upstream from the centre, until the dam is about three-quarters full, returning again nearly to the centre, when the dam is under its calculated flood. The angle of resultant also is always kept within the limit of the angle of friction, so that the dam has no tendency to move on its base. About the simplest form of reinforced-concrete dam adapted to moderate head and hard foundations consists of a series of buttresses variously spaced from 12 to 18 feet apart, and covered with a deck of concrete reinforced between the different bases as a beam after the usual formula. The factor of safety throughout is said to be never less than five in all its relations. But little reinforcement is used in the buttress except at the edges

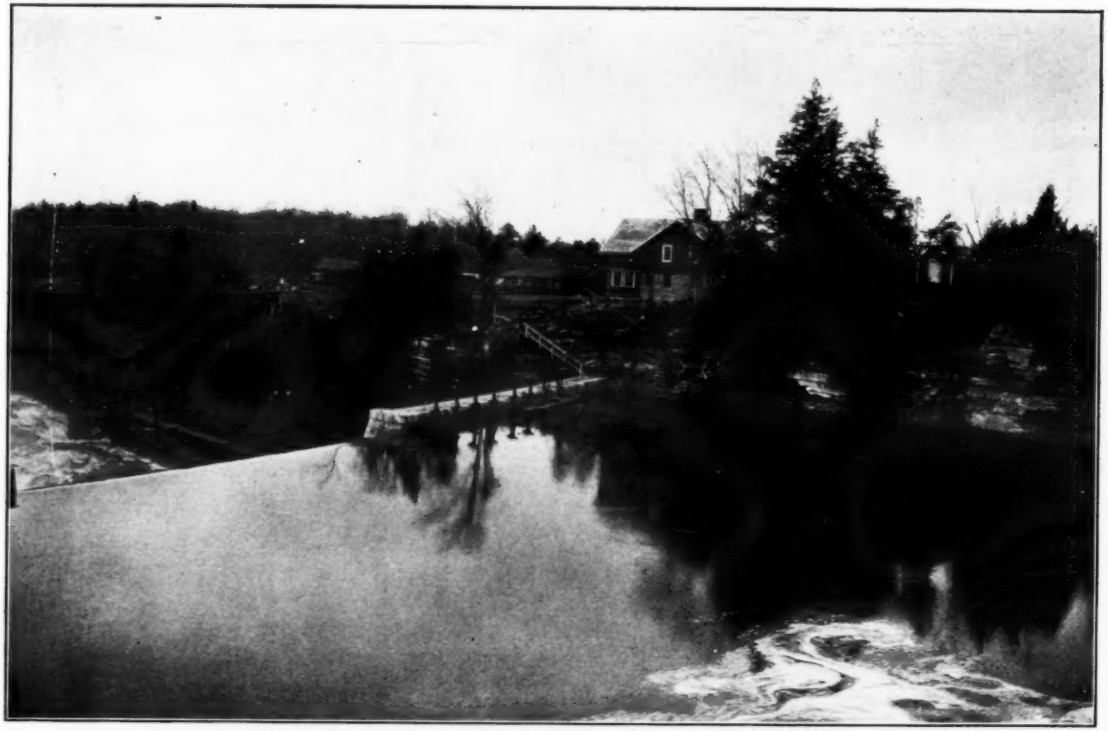
and around the openings, which are left for convenience and to save material. The deck reinforcement, however, is abundant, and is within 1.5 inches of the lower side, leaving from 10 inches to several feet of concrete between the steel and the water. The thickness of the deck necessarily increases from top to bottom with the increase of head. The concrete in the deck is mixed 1:2:4, usually with five aggregates, and is poured into the forms in the condition known as slop concrete. This insures a thorough coating of the steel with cement, and furthermore, insures a density of concrete which seems to be sufficient to forestall porosity altogether.




CROSS-SECTION OF THE PATAPSCO DAM. A HOLLOW REINFORCED-CONCRETE STRUCTURE.

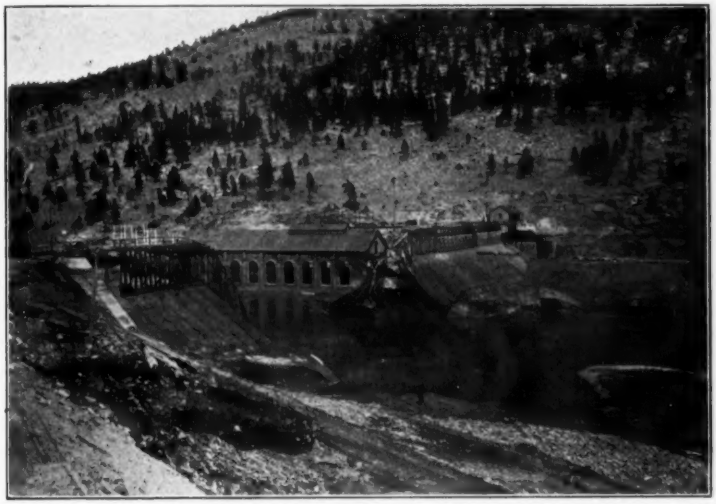
A dam of this design, when on rock, has no continuous base and therefore cannot be treated by water pressure finding its way through seams in the rock, and exerting a lifting pressure under them. On gravel or other porous foundations an artificial base is first laid down covering the entire area, but in such case this base or floor is pierced with numerous weep holes, so that upward pressure is again forestalled.

Being hollow, reinforced-concrete dams not only possess the unusual features of interior inspection, but the hollow space puts at the disposal of the engineer a valuable space from which to work the various adjuncts, such as flash boards, waste gates, log sluices, movable crests, etc., all of which are handled from the inside of the dam, allowing the whole width of the river to be utilized for rollway, instead of being more or less obstructed by bulkheads. The interior of the dam admits of plenty of space for a passage-way, which may



THE DAM OF THE UTICA GAS AND ELECTRIC COMPANY, TRENTON FALLS, N. Y.

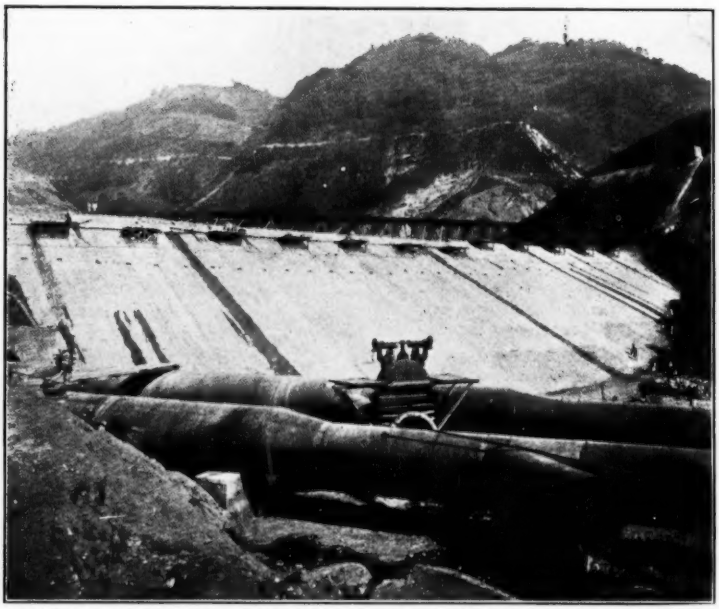
vary from an ordinary foot bridge to the equipment of a complete power plant as seen on page 38 representing a cross section of the Patapsco dam in Chester, Md. This dam is 200 feet long and 30 feet high and the interior is equipped with three 500 horse-power horizontal turbines direct-connected to generators. It contains also the exciters and other electrical features such as switchboards, etc. To guard against possible moisture the power house itself is enclosed with 4-inch walls of ferro-inclave, entirely separated from the structure of the dam itself.



BREAK IN THE HAUSERLAKE DAM OF THE HELENA POWER TRANSMISSION CO., LOOKING DOWN-STREAM.

Another feature in reinforced-concrete dam construction is the spacing of piers, which by leaving a free waterway often enables this type of dam, on certain foundations, to be built without the use of a coffer dam. Piers are first carried up in caissons to a uniform grade a few feet above the ordinary water level, and then the superstructure is completed while the water runs freely between the piers.

Of the many other types of dams the steel-frame dam is of some importance and the accompanying illustration shows such a dam erected by the Helena Power Transmission Company across the Missouri River at Helena, Montana. Its life, however, was not long. This dam was 630 feet long and 75 feet high. The lower section of the upstream side was of concrete behind which was rubble masonry; the upper section was made of structural steel trusses 9 feet 9 inches



NECAXA DAM OF THE MEXICAN LIGHT AND POWER COMPANY BEFORE THE ACCIDENT.

apart and faced with steel plates. In the front of the upstream concrete toe, in order to prevent water from washing beneath the dam, steel sheet piling had been driven. Only the upper section of the downstream side was faced with steel plates, the remainder of the downstream end being made entirely of wood. The top of the dam bore a flashboard structure faced with steel plates at both ends, while in the middle an opening of 50 feet was left to pass floods. This, however, could be closed after the flood had passed. This dam failed April 14, 1908, at the time when the matter of acceptance and final settlement was in the hands of the attorney of the power company. The cause of the failure was the passing of the water under the sheet steel piling, underwashing the rubble concrete, the supports for the structural steel being carried away and finally making a breach of 300 feet in width.

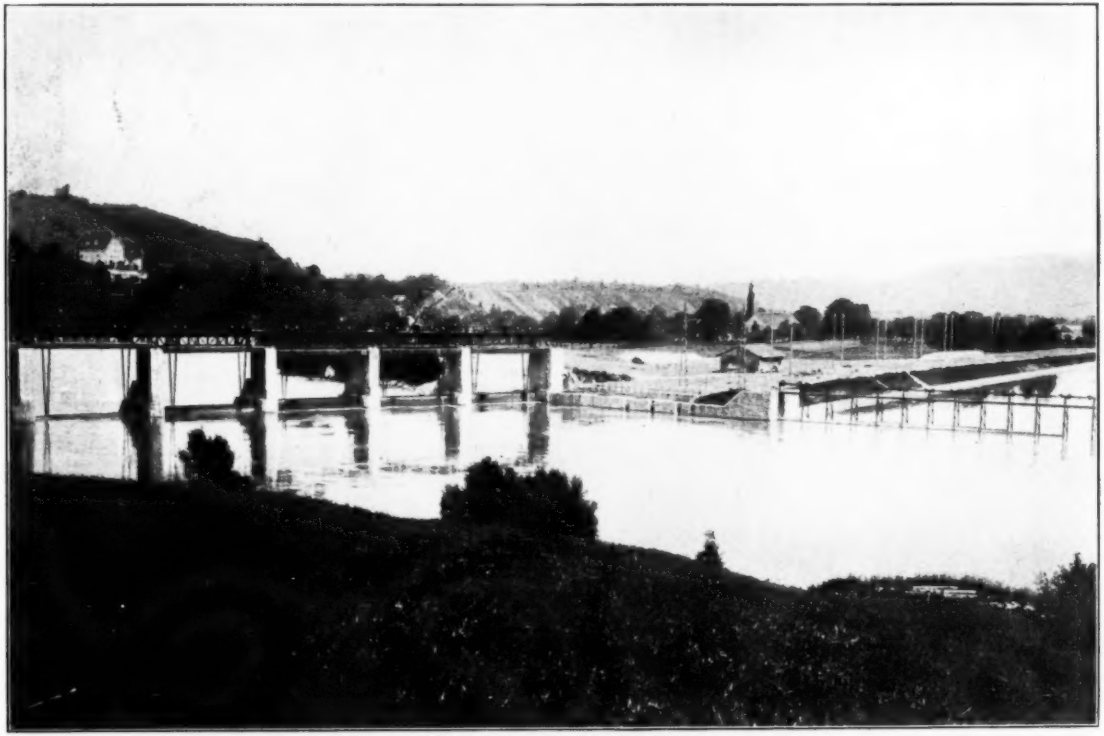
The earth dam is another type of dam of which many have been built of late years and many have failed. They have either a concrete earth being sluiced into place. One of this type was built by the Necaxa Light and Power Company, Mexico. It has a total height of about 190 feet, the top has a width of 54 feet, while the upstream

side is 3 on 1, the downstream side 2 on 1. The dam has a total estimated contents of 2,130,000 cubic yards, of which on May 20, 1909, 750,000 cubic yards, forming part of the upstream portion, slid backward into the reservoir. The dam is made up of a puddle core, on both sides of which are mixed clay and rock and both the upstream and downstream faces are covered with heavy layers of rock. The manner of construction, as given in a paper by F. C. Pearson and F. O. Blackwell before the American Society of Civil Engineers, is as follows:

"The ground was first cleared and stripped, and a trestle to support the flume was erected, and low earth dikes were made at the upstream and downstream limits of the fill, to hold the mud and water. The material was then sluiced in, the pipes discharging near the embankments so that the boulders and gravel were disposed at the face, and the fine mud in the centre of the dam. The dikes were raised as the dam filled and the water spilled over the upstream face into the pond. During construction the water of the river passed through the discharge gates, which were made large enough for this purpose."

It is claimed that the principal cause of the failure of the dam was the use of tepetate instead of rock, as specified, the former having a specific gravity only half as great as the latter; and as the sluicing was carried on with a great volume of water, the tepetate, because of its lightness, failed to displace the water sufficiently from the core, and the clay of which the core was made, also not being of the proper quality, did not harden, so that as at the time of the accident the water

GENERAL VIEW OF THE NECAXA DAM UNDER CONSTRUCTION, SHOWING FLUMES FOR FLUSHING IN THE MATERIAL.



STONEY ROLLER SLUICE DAM AT THE BEZNAU PLANT, SWITZERLAND.

was low, the dam above the water level flowed backward into the reservoir. It is understood that the dam is at present being restored with the use of proper materials.

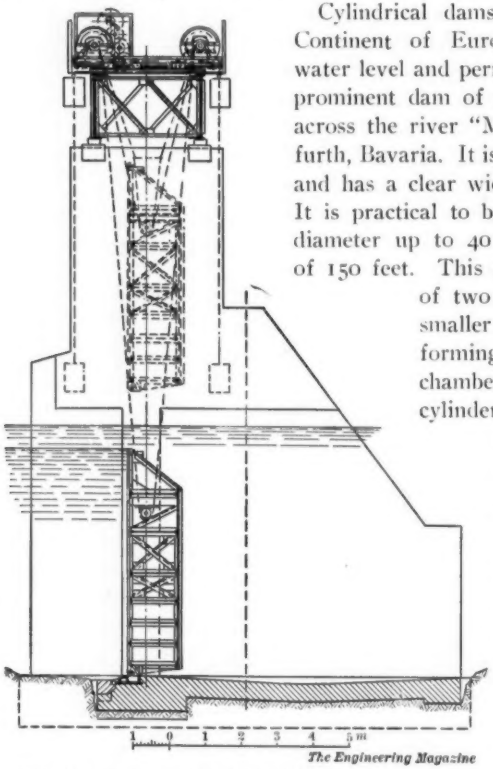
Of the many movable dams in use in connection with hydroelectric developments probably the most common are those of the butterfly type, flashboards, roller sluice gates, cylindrical dams, and so-called bear traps, all of which are designed, more or less, for raising the water level. The "Stoney" roller sluice gate is used to a great extent by British engineers, there being also a great number in Switzerland.

EARTH DAM WITH CONCRETE CORE, UNDER CONSTRUCTION.
One of the smaller dams in the Necxaca hydroelectric power development, Mexico.

The accompanying illustration (page 44) shows a cross-section of this type as used in the "Beznau" plant, Switzerland. The gates move in vertical grooves on roller trains in the abutting piers. Both gate and rollers are counterbalanced so that a gate under pressure can be easily moved by hand—if not exceptionally large, in which case motors or air or hydraulic pressure may be used. The discharge of the water in this type of dam takes place from beneath the gate; thus the foreign material collecting at the bottom is readily disposed of and the opening serves as a fish-way at the same time.

An exceptionally good example of a butterfly dam will be found in connection with the Chicago Drainage Canal power plant, there being two of these installed, the one having a width of 12 feet and the other

48 feet. They are practically alike in detail of construction and in mode of operation, are built of structural steel and are 45-degree sectors of a cylinder with a 26 foot radius. By means of this dam the water level may be raised 18 feet, these gates being raised and lowered by air pressure mechanism.



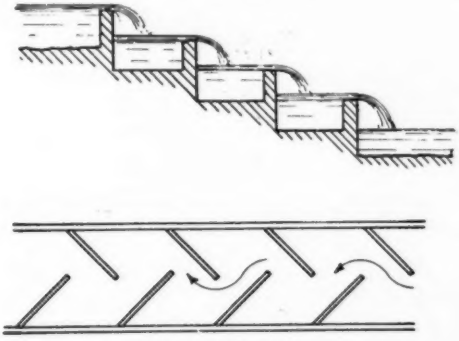

GENERAL ARRANGEMENT OF STONEY ROLLER SLUICE DAM.

Cylindrical dams are in use on the Continent of Europe for raising the water level and permitting navigation. A prominent dam of this type is installed across the river "Main," near Schweinfurth, Bavaria. It is 13.5 feet in diameter and has a clear width of about 60 feet. It is practical to build such dams of a diameter up to 40 feet and of a span of 150 feet. This type of dam consists of two cylindrical shafts, a smaller within a larger one, forming an annular airtight chamber. When lowering the cylinder the water flows through the inner shell and the buoyancy effect is thereby reduced. The principal advantages claimed for this type are, the elimination of piers in the middle of the river, simplicity of construction in dam as well as machinery, and ease of operation.

The bear-trap dam consists of two leaves hinged on a foundation, the upstream leaves overlapping the downstream leaves when the gate is lowered. A culvert leads from upstream to a point under the leaves, and a second culvert leads from here downstream; they are provided with valves. When the first culvert is open, but the second remains closed, the hydraulic pressure under the leaves causes them to rise provided the head from upstream is sufficient. Reversing the process causes the leaves to drop. The angle formed by the two

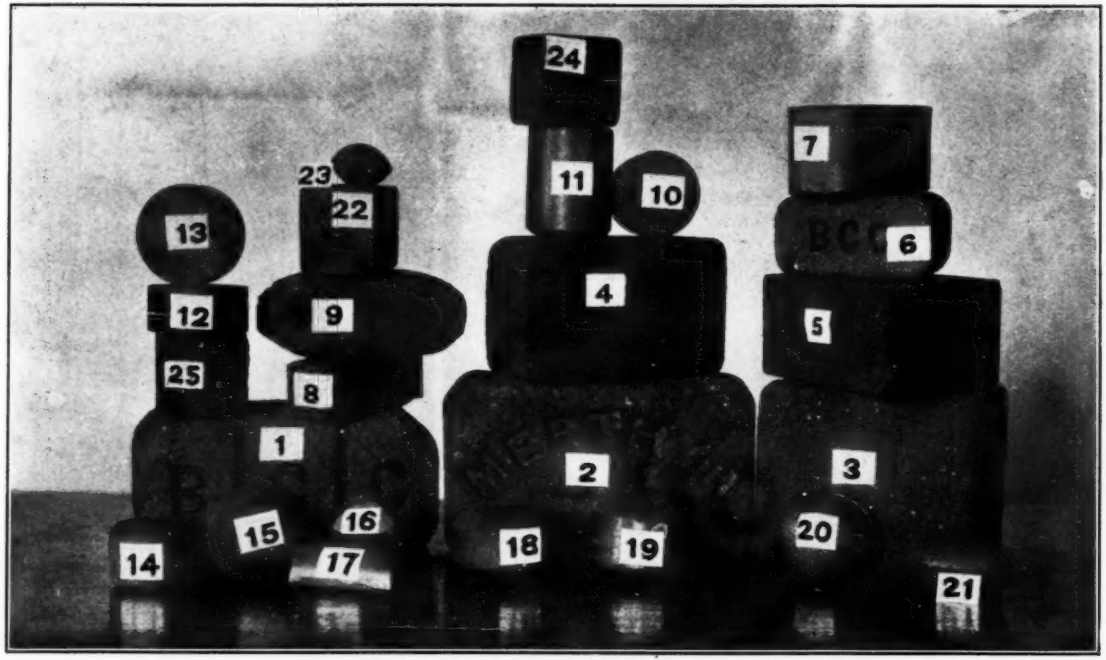
leaves in their raised position should be about 100 to 105 degrees so as to operate properly under the pressure.

Flashboards are used for the purpose of increasing the head during flood periods when the tail water is higher than usual, in which event, with surplus water flowing over the crest of the dam, the head would otherwise be materially reduced. They are designed to retain a certain amount of water which would otherwise be discharged over the dam; should the pressure exceed a predetermined limit the supports give way and the boards are washed down stream. This, in any case, means a loss of planking; in many instances, however, the flash boards are removed in anticipation of high floods. Permanent flash boards of steel may be so anchored to the dam as to be tipped automatically by high floods so as to permit the water to pass, the flashboards being again placed in position after the flood.



TYPES OF FISHWAYS.

Fishways, which are usually specified by the governments, are practical passageways across dams for fish to make their periodical migration up stream for breeding purposes. They are built, usually on one side of the dam, either in the form of a chute with a series of baffles for reducing the velocity of the water, which must not be greater than 6 to 8 feet per second, or in the form of steps or cascades forming pools or resting places, the fish jumping upstream from step to step, the rise of the step depending upon the kind of fish and their habits; data on this subject can be obtained from the government or local authorities.




A GROUP OF BRIQUETS OF AMERICAN AND EUROPEAN MANUFACTURE.

1. Made by Briquet Coal Co., of Staten Island, N. Y., now located at Murphysboro, Ill. 2. Briquet made in England or Wales for locomotives or steamships. 3. Made by U. S. G. S., on English machine with bituminous coal and water-gas pitch. This was original size of briquet produced by the English (Johnson) machine, but the mold plate was reduced in thickness to make briquets of shape and size shown by 4 and 5. 4 and 5. Made by U. S. G. S., on English machine. 6 and 7. Small briquet made by Briquet Coal Co. 8 and 9. Made from California lignite on German (Exter) press at Pittsburg plant of U. S. G. S. 10 and 11. Made on Ladley press of National Pressed Fuel Co., at Indianapolis, Ind. 12 and 13. Made from California lignite on hydraulic hand-press at Pittsburg plant, U. S. G. S. 14 and 15. Peat briquets made by wet process on open mold machine. 16 and 17. Peat briquets made by Milne patent process. 18 and 19. Made on Renfrow press at Norfolk plant of U. S. G. S. 20 and 21. Eggettes made on roll type of press of American Compressed Fuel Co., of Chicago, Ill., at St. Louis plant of U. S. G. S. 22. "Industrie" (German) lignite briquet. 23. Coalettes (small eggettes) made from anthracite culm and coal tar pitch by the National Briquet Machinery Co., Brooklyn, N. Y. 24. Made from peat with 50 per cent. of a mixture of oil and asphalt by the U. S. Briquet Co., San Francisco, Cal. 25. Made for domestic use from coal yard screenings and asphaltic pitch by J. R. Allen, Summerville, Cal.

# THE FUEL-BRIQUETTING INDUSTRY.

*By Charles L. Wright.*

Published with the Approval of the Director of the U. S. Geological Survey.

Mr. Wright is Assistant Engineer, U. S. Geological Survey, in charge of the fuel-briquetting section. He had charge of the chemical and physical tests of briquets and binders at the St. Louis Fuel-Testing Station, superintended the installation of the Government briquetting plant at Norfolk, and later succeeded to charge of the briquetting investigations and installed the briquet plant at Pittsburg, Pa. His article is prepared under the auspices of the U. S. Geological Survey, as a concise and comprehensive review of the "State of the Art." This initial section on plant, materials and processes will be followed by a second largely illustrated part descriptive of equipment and machinery for briquetting, a discussion of the properties of briquetted fuel, and some statistics of production.—THE EDITORS.

IN many industries, by-products which were at first only waste materials and troublesome to dispose of, after investigation, have been utilized with a resulting profit that was not considered possible at the beginning. In the coal-mining industries of the United States the utilization of mine waste is at the present time receiving much more attention than it ever has in the past, as mine owners are realizing that by means of briquetting and the gas producer this waste can be converted into fuel suitable for any purpose, at a sufficient profit to warrant the investment required to install the necessary machinery. It is the purpose of this article to discuss certain features of the briquetting process and its value to the coal-mining industry of this country .

In England the manufacture of briquetted fuel has opened up wide channels for the consumption not only of the immense quantities of slack obtained wherever mining operations for coal are carried on, but also for the almost equally large bulk of pitch resulting from the operations of the tar industry.

In Germany the lignite briquetting industry has developed rapidly since it was placed on a commercial basis about thirty years ago, and it is reported that German briquetting companies are now paying 15 to 20 per cent yearly dividends.

### *Definition of Briquetted Fuel.*

The term "briquetted fuel" is applied in the United States to that form of artificial fuel which is prepared by compressing into molds the finely divided product from coal and lignite mining, this product in most cases requiring the admixture of a bonding material or binder to hold the particles together, although certain lignites possess suffi-

cient natural bituminous matter to cohere without addition of artificial binder, if subjected to very heavy pressure in the molds.

### Historical Statement.

According to Menzel, the oldest record states that ball-shaped compressed coal originated in China. Hugh Platt in 1603 described in a pamphlet a new compressed fuel manufactured in the year 1594 in the neighborhood of Lukeland in Germany; made of coal-dust, saw-dust, and oak tan-bark with cow-dung as a binding material.

Jars in the year 1776, Clire in 1813, inform us that near Achen and Luttich balls and eggs were made from coal dust with 10 to 15 per cent of loam, for house fuel.

In 1799 Chavanne received an English patent on the application of coal formed in the shape of cakes.

In 1832 E. Marsais patented in St. Etienne a method of preparation of pressed coal, from a mixture of coal tar and slack. His briquets, however, were not hard enough.

In 1842 Marsais obtained a patent for the use of soft coal-tar pitch as a binding material, and erected in Berard, near St. Etienne, the first briquetting plant, and four years later he erected the second briquetting plant at Givors.

In 1843 Wylam used hard coal-tar pitch as a binding material for slack coal, and in 1846 the first briquetting plant in England was established at Newcastle-on-Tyne.

In 1852 the first Belgian briquetting plant was erected at Montignies-sur-Sambre.

In 1858 Austria's first briquetting plant was erected at Brandeist near Prague.

The first German briquetting plant on record was erected at Mulheim-on-the-Ruhr in Prussia in the year 1861.

In 1867 France already had thirty-one briquet manufactories which produced annually more than one million tons of briquets.

In 1869 Belgium had nine briquetting plants with a yearly production of 515,000 tons.

The first briquetting plant in the United States, according to C. T. Malcolmson, (*a*) was established in 1870 by E. F. Loiseau at Port Richmond, Philadelphia.

### Fuel Briquetting Plants in the United States.

Several plants have been established in different parts of the United States since 1870, but only those established in the last five years have been successful on a commercial scale.

(*a*) Briquetted Coal and Its Value as a Railroad Fuel. Roberts and Schaefer Company, Chicago, 1909.

In 1908, according to E. W. Parker (*b*) the following plants in the United States were in operation or nearly completed; Standard Fuel Company, Birmingham, Ala.; Western Fuel Company, Oakland, California; Arizona Copper Company, Clifton, Ariz.; Indianapolis Pressed Fuel Company, Indianapolis, Indiana; Semet-Solvay Company, Detroit, Michigan; Western Coalette Fuel Company, Kansas City, Mo.; New Jersey Briquetting Company, Perth Amboy, N. J.; Robert Deviller's Plant, Brooklyn, N. Y.; D. Grieme Coal Company, New York City; The Briquet Coal Company, Murphysboro, Ill.; The Scranton Anthracite Briquet Company, Dickson City, Pa.; Rock Island Coal Mining Company, Hartshorne, Oklahoma; United Gas Improvement Company, Point Breeze, Philadelphia, Pa.; Northwestern Improvement Company, Tacoma, Washington.

There are several other plants in process of erection or not at present in operation.

The plant at Bankhead, Alberta, in British Columbia, has the largest output of any plant in America, its production during the season of 1908 and 1909 having been about 140,000 tons of 1⅞-ounce briquets made from western anthracite coal.

There are several reasons for briquetting fuel, the most important of which are the following

1.—To convert mine waste into a commercial fuel.

2.—To utilize the low grade fuels, such as lignite and sub-bituminous coals, peat, etc., and convert them into fuels suitable for local use where they are found.

3.—To produce a satisfactory household fuel from bituminous coal, or refuse from coal yards.

1.—In the modern methods of mining bituminous and anthracite coals, large quantities of slack and culm are produced; and while in some sections of the country there is a market for the slack, for use in industrial plants provided with mechanical stokers, yet in other sections of the country there is not only no market for the slack, but the mine owners are put to a positive expense to haul it away from the mines and dump it in great piles which frequently become fired by spontaneous combustion, being gradually consumed. For this reason the coal-mine operators are at the present time interested in the development of the briquetting industry in the United States, and even if the process should not yield much profit of itself, it would do away with the handling of the slack and convert it into a fuel that will readily sell for at least as much per ton as the best lump coal from the

(*b*) Coal Briquetting in 1908. Advance chapter from Mineral Resources of the United States, calendar year 1908. U. S. Geological Survey, Washington, D. C.

same mine, and usually for more. This saving and utilization of a by-product is strongly to be commended as helping to conserve our natural resources, a question which is arousing so much interest and thought at the present time.

2.—To utilize the low-grade fuels of the western and southern states.

In certain portions of the United States, notably Texas, North Dakota, Colorado, Montana, and California, are found beds of lignite covering large areas and from a few inches to over thirty feet in thickness. These lignite beds are in many instances situated long distances from bituminous and anthracite fields, and the obtaining of a satisfactory fuel supply is a problem of great interest to people living in these districts as upon the solution of this problem depends the development of manufacturing industries there. Considerable interest has been manifested in the United States recently in the development of these fuel supplies of relatively low heating values. European countries have been developing and improving their low-grade fuel supplies for many years, so that at the present time the artificial preparation of such low-grade fuels as peat, lignite, and sub-bituminous and the slack of bituminous and anthracite has become an extensive industry. Briquetting and the manufacture of producer gas have been the means most generally adopted in Europe to convert these low-grade fuels into useful fuels, and the industrial success of Germany has been due in no small measure to the production of useful fuel from practically worthless raw material.

Lignites in their raw states are not satisfactory fuels for either domestic or industrial purposes, on account of their inability to resist the effects of weathering. They crumble to slack when dried, and after exposure to wet and dry weather for a few weeks they become slacked to such an extent that they are burned with difficulty and only with special apparatus. The American lignites tested by the United States Geological Survey were found to contain from 30 to 40 per cent of moisture at the mine, and this high per cent of moisture partially accounts for the low heat value and low efficiency of this fuel. In the process of briquetting lignites the moisture is reduced to 10 to 15 per cent and their heat values are thereby improved from 35 to 50 per cent. This improvement in heat value is of especial importance when the fuel is to be shipped to a market at some distance from the mine, as it saves transportation charges on the water that is removed by briquetting, this saving amounting to as much as 32 per cent in some instances.

3.—To produce a satisfactory household fuel from bituminous coal.

In certain parts of the United States, notably New England, where fuel has to be obtained from mines located at a distance, the transportation charges are so great that the prices of anthracite and bituminous coals are very close to each other, so that when the added advantage of the cleanliness of the hard coal is considered it is not strange that anthracite is used for a domestic fuel to the exclusion of bituminous coal. In these sections there should be a market for bituminous-coal briquets as a house-heating fuel, as they could be made at the mines and sold at a price to compete with anthracite; and if properly made (and I must emphasize the word *properly*), the briquets should have satisfactory heating capacity and cleanliness in comparison with hard coal.

Most fuel materials can be briquetted if the proper binder is used and the proper briquetting conditions are determined. Naturally some material will cost more to briquet than others, and whether a certain fuel can be briquetted on a commercial scale with profit will depend on several conditions such as:

Cost of raw material.

Cost of binder.

Distance of market for briquets from coal fields which will govern the price of high-grade fuel in the same market.

The first two conditions the cost of raw materials do not require any discussion; but of the third it may be said that where the cost of mining is not excessive and the fuel mined is of an inferior quality in its natural state, it is sometimes the case that a high price is obtained for a good quality of fuel, shipped from a distance into the market adjacent to the mine producing the inferior coal. These conditions of inferior local fuel, cheaply mined, and a high selling price for high-grade fuel, are very favorable to the establishment of the briquetting industry, as a means of converting the low-grade fuel into a better fuel that will sell at such a price as to allow a sufficient margin above the cost of briquetting to give satisfactory returns on the investment in the briquetting plant.

## Briquetting with Binders.

Anthracite culm and screenings, bituminous slack, coke breeze, and certain lignites and sub-bituminous coals, require the addition of a binding material in order to make them into briquets. It will therefore be of interest to give a brief statement about these binding materials.

Binders Used.—The largest item in the cost of briquetting, using a binder, is the cost of the binder itself; and so it is not surprising that in the last fifteen years thousands of patents have been issued in different countries for binding materials for briqutting fuels. Many of them are complex, being made up of several substances, but the greater number of them have not been found practical, as in some cases the cost was prohibitive, while in other cases the complex nature of the binder made the briquetting process too complicated.

Among the materials suggested for binders, the following may be mentioned: Clay, lime, magnesia, plaster of Paris, Portland cement, natural cement, water glass, rosin, pitch, pine-wood tar, hard-wood tar, wood pulp, sulphite liquor (from paper mills), sulphite pitch (from sulphite liquor), beet pulp, lime cake, beet-sugar molasses, cane-sugar molasses, corn starch, potato starch, flour, flax straw, flax-straw syrup, slaughter-house refuse, garbage, blast-furnace tar, producer-gas tar, illuminating-gas tar, pitches of various grades made by distilling these tars, natural asphalts such as impsonite, gilsonite, maltha, refined Trinidad, etc., crude petroleum, petroleum residum, wax tailings, acid sludge, asphalt tar, Pintsch-gas tar, etc.

Of these binders, only a few have been found practical and those in use at the present time are fewer yet. Coal-tar pitch is the binder most generally used in Great Britain, Germany, France and Belgium. The United States Geological Survey has found water-gas tar pitch an excellent binder and it is the binder most generally used on the tests made by the Survey.

Sulphite liquor and cell pitch, by-products of the wood-pulp paper industry, although at first not found satisfactory binders on account of not making water-proof briquets, have lately been used with more success and in the Pollacsek process in Hungary, cell pitch has a favorable outlook.

In this brief paper I will not try to discuss the binders in detail and those interested will find this subject treated in an admirable manner by James E. Mills in United States Geological Survey Bulletin No. 343, entitled "Binders for Coal Briquets." It would be wise, however, to describe here the following binders:

*a.* Coal-tar pitch is obtained from the distillation of coal tar, a by-product of the coal-gas industry. There are three grades of this pitch, namely: soft, medium, and hard pitch. Soft pitch has greater binding power than the hard pitch and therefore less of it is required, but it has the disadvantage of producing more smoke and softening at a lower temperature in the fire. All tar pitches have the disadvan-

tage of producing smoke when burned, but as they make waterproof briquets they have been more extensively used in European countries than any other binders for making coal briquets.

*b*. Water-gas pitch is made by distilling water-gas tar, which is a by-product of the water-gas industry. This pitch is therefore a petroleum product, as it comes from the petroleum oil used to enrich the water gas. What was said above about the characteristics of grading of coal-tar pitch applies equally well to water-gas pitch.

*c*. Asphalt pitch is derived from natural bituminous rock such as impsonite, gilsonite, maltha, etc., and is probably superior in binding qualities to coal-tar and water-gas pitch, but has as yet been used only to a limited extent.

### Briquetting without Binder.

Certain kinds of lignites, or brown coals, possess sufficient binding qualities to be briquetted without adding any artificial binder to them, although a much higher pressure must be used than when briquetting material with added binder, as this pressure is necessary to soften the inherent binder.

Lignites suitable for briquetting without binder are found in Germany, Austria, Italy, and the United States.

Germany is the greatest producer of lignite briquets, having made 14,227,218 tons of this fuel in 1908, while Austria comes next with 130,000 tons in the same year.

A special type of press, known as the Exter-press, is used in Germany for briquetting lignite and peat, but the latter fuel is not briquetted profitably at the present time on account of the high moisture content which must be removed by drying. Peat has been more successfully prepared for fuel by air-drying and wet-pressing in presses similar in construction to those used for making clay products.

In the manufacture of briquets certain conditions are observed, regulating shape, dimensions and weight.

Briquets are made in various shapes of which the following may be mentioned as the most important, parallelopipedon, cubical, spherical, cylindrical, with flat or convex ends, (the length of the cylinder generally being about the same as the diameter), egg-shaped, pillow-shaped, and briquets elliptical in one cross section and rectangular in the other, this latter shape being important as it is the one adopted for lignite-coal briquets in Germany.

The weight varies from less than 1 ounce up to 22 pounds, according to the shape and the market for which the briquets are made.

English block briquets weigh about 8 pounds on the average while the German brown-coal (lignite) briquets weigh approximately 1 pound each. The eggette shapes more commonly found in Belgium and France are much smaller and weigh from 1 to 6 ounces.

Good briquets should have a firmness equal to that of a good natural bituminous coal, and to obtain this strength from 5 to 7 per cent of coal-tar pitch is required with bituminous slack and anthracite culm, but certain lignitic coals and peat possess sufficient natural bituminous matter to briquet without adding any binding material to them.

When broken, good briquets should fracture with a clean, bright, granular surface; the edge should not crumble easily.

Briquets made from bituminous slack show less than 2 per cent of disintegration in transit, while the raw fuel under the same conditions would lose from 30 to 50 per cent.

Briquets from bituminous slack or anthracite culm show an increased efficiency in combustion of from 5 to 15 per cent over the run-of-mine coal from the same mine. Lignite briquets may have an efficiency from 25 to 50 per cent higher than the raw lignite, owing to the reduction of moisture in the process.

If made with medium or hard pitch, briquets will burn with less black smoke than the natural coal.

The regular size of the larger blocks permits of an accurate consumption of fuel in a given operation by the number of blocks used.

# THE DESIGN, CONSTRUCTION AND OPERATION OF HIGH-LIFT CENTRIFUGAL PUMPS.

*By Franz zur Nedden.*

## IV. THE TURBO-PUMP DIAGRAM.

Mr. zur Nedden's critical discussion of the centrifugal pump, the fourth part of which is here presented, has already dealt with the mechanical and hydraulic losses of turbo-pumps, solutions of the problem of balancing axial thrust, and structural features and manufacturing considerations. The instalment here published considers the turbo-pump diagram and its practical interpretation in service. Space limitations dictate the postponement until May of a concluding section on Special High-Lift Turbo-Pumps.—THE EDITORS.

IN considering the turbo-pump diagram we must dismiss from our minds the idea of such a diagram as is obtained from the normal piston pump. The two differ radically. The diagram of a piston pump (or indeed of any oscillating machine) is indicated by the machine itself. The pen of the indicator moves up or down according to the variations of the internal cylinder pressure, and records its position on a paper drum which moves in direct proportion to the stroke. The picture portrays the proceedings within the cylinder during a single stroke. The abscissae of the diagram signify spaces, the ordinates signify forces, and consequently the area measures power.

The turbo-pump diagram, on the contrary, signifies the registration of the heads produced by the pump at different deliveries, the heads being the ordinates and the delivery abscissae. There are at present no instruments for registering these data automatically. The diagram is made by tracing a curve through a number of points determined experimentally. Its area has no direct mathematical significance.

In direct contradistinction to cylinder diagrams, it does not directly reflect the internal phenomena, but only illustrates the variations of external phenomena under varying working condition. Nevertheless it is not at all impossible to draw, from the form of this diagram, valuable deductions as to the internal operation of the turbo-pump. Above all, it is absolutely indispensable to a clear determination of the suitability of the turbo-pump for certain conditions, and it is of primary interest to the practical engineer who superintends the operation of the pump.

| | | Test Number. | 1 | 2 | 3 | 4 |
|---|---|---|---|---|---|---|
| Motor. | Observed | Number of revolutions per minute. | 1480 | 1480 | 1470 | 1465 |
| | | Indicated electric energy, KVA... | 51,1 | 62,9 | 82,7 | 84,6 |
| | | Motor efficiency according to guarantee $\eta_M$ %..... | 91,5 | 92,0 | 90,5 | 90,5 |
| | Calculated | BHP= $\frac{\text{KVA}:\eta_M}{0{,}746:100}$ | 62,75 | 77,8 | 100,3 | 102,55 |
| Pump. | Observed | Pressure head as indicated by by manometer, lbs per sq. inch. | 148,0 | 130,0 | 65,5 | 4,3 |
| | | Suction head as indicated by vacuum meter, inches of mercury | 7,4 | 7,8 | 8,4 | 9,25 |
| | | Level difference between both instruments, HD in ft..... | 0′ 7″ | 0′ 7″ | 0′ 7″ | 0′ 7″ |
| | | Delivery, Q in imp. galls. per min. | 429 | 579 | 772 | 832 |
| | | Pressure head HP in ft..... | 341 | 300 | 153 | 10 |
| | | Suction head Hs in ft..... | 8′ 4″ | 8′ 10″ | 9′ 6″ | 10′ 6″ |
| | Calculated | Total manometric head H=HP+Hs+HD in ft..... | 349′ 11″ | 309′ 5″ | 163′ 1″ | 29′ 1″ |
| | | Water horse power HPW= $\frac{Q\text{-}10\text{-}H}{33000}$ ..... | 45,45 | 54,2 | 38,2 | 5,32 |
| | | Efficiency $\eta\%=100\frac{\text{HPW}}{\text{BHP}}$ ..... | 72,5 | 69,9 | 38,0 | 5,2 |
| | | Notes. | | | Gauge Full Open. | |

TABLE 1.—TEST OF A THREE-STAGE HIGH-LIFT TURBINE PUMP, LIFTING NORMALLY 500 GALLONS A MINUTE AGAINST A HEAD OF 335 FEET, COUPLED DIRECT TO 75 HORSE-POWER THREE-PHASE ALTERNATING-CURRENT MOTOR, 1480 R.P.M. AT 50 CYCLES CONSTANT

These diagrams are usually based upon constant or nearly constant speed of revolution. Their method of development will be clear without much additional explanation if Figure 35 is compared with Table 1. Both register the some experimental results, the one in tabular and the other in graphic form. The curves shown in Figure 35 are characteristic of normal operation of the most modern types of turbo-pump. Above the same delivery scale, but each upon its own ordinate, are plotted the three curves of effective horse-power, efficiency, and head; this last is called the characteristic curve.

What readings can be determined from this diagram?

If the gate valve on the pump delivery be entirely closed (the pump being coupled directly to a three-phase alternating-current motor) the manometer on the outlet chamber shows about 360 feet head (delivery 0, point 11). If the delivery valve is gradually opened an increasing volume of water passes through the pump, the pressure remaining nearly constant, while the load demand on the motor and the efficiency rise rapidly (points 9 and 10). When the pump delivers volumes near to the normal (points 1, 2, 7 and 8) the efficiency

| 5 | 6 | 7 | 8 | 9 | 10 | 11 |
|---|---|---|---|---|---|---|
| 1470 | 1475 | 1480 | 1480 | 1485 | 1490 | 1490 |
| 84,1 | 73,8 | 60,1 | 57,2 | 36,8 | 28,5 | 24,3 |
| 90,5 | 91, | 92, | 92, | 90, | 88, | 86,5 |
| 102,0 | 90,05 | 74,2 | 70,4 | 44,55 | 33,6 | 28,2 |
| 30,0 | 102,5 | 134, | 143, | 155, | 154, | 138,7 |
| 9,0 | 8,4 | 8,1 | 7,5 | 7,2 | 6,65 | 6,65 |
| 0′ 7″ | 0′ 7″ | 0′ 7″ | 0′ 7″ | 0′ 7″ | 0′ 7″ | 0′ 7″ |
| 809, | 678,5 | 546, | 488,5 | 234,5 | 91, | 0 |
| 69 | 236 | 308 | 330 | 357 | 354′ 6″ | 320 |
| 10′ 2″ | 9′ 6″ | 9′ 2½″ | 8′ 6″ | 8′ 2½″ | 7′ 6½″ | 7′ 6½″ |
| 71′ 9″ | 246′ 1″ | 317′ 9½″ | 339′ 1″ | 365′ 9½″ | 362′ 7½″ | 328′ 1½″ |
| 19,5 | 50,5 | 52,6 | 50,1 | 26,0 | 10,0 | 0 |
| 19,1 | 56,0 | 70,9 | 71,1 | 58,3 | 29,8 | 0 |
| | | | | | | Gauge Closed. |

TABLE I.—TEST OF A THREE-STAGE HIGH-LIFT TURBINE PUMP, LIFTING NORMALLY 500 GALLONS A MINUTE AGAINST A HEAD OF 335 FEET, COUPLED DIRECT TO 75 HORSE-POWER THREE-PHASE ALTERNATING-CURRENT MOTOR, 1480 R.P.M. AT 50 CYCLES CONSTANT (Continued).

remains fairly constant, but the pressure begins to drop, gradually at first, but faster and faster with increasing delivery. Toward the last the pressure falls very rapidly, while the delivery increases but little, and the efficiency begins to decrease (points 3, 5 and 6). The final limit of pressure is determined by the suction head, increased by the resistance of the apparatus itself (foot-valve friction and similar items) when the pump runs with the sluice valve wide open (point 4). Delivery and motor load are simultaneously at maximum. These results, it is understood, are based on the supposition of working conditions as they are to be found in the testing department of the manufacturing plant, where we are not dealing with a certain actual static head, but the resistance is produced only by variable throttling by means of a valve in the delivery pipe.

The limits of this discussion make it impossible to take up in detail the causes of this behavior on the part of the pump. We must, however, still consider the variations of this diagram which will be found when the speed of revolution (heretofore supposed to have been kept constant) is subjected to change. Delivery, of course, must vary in

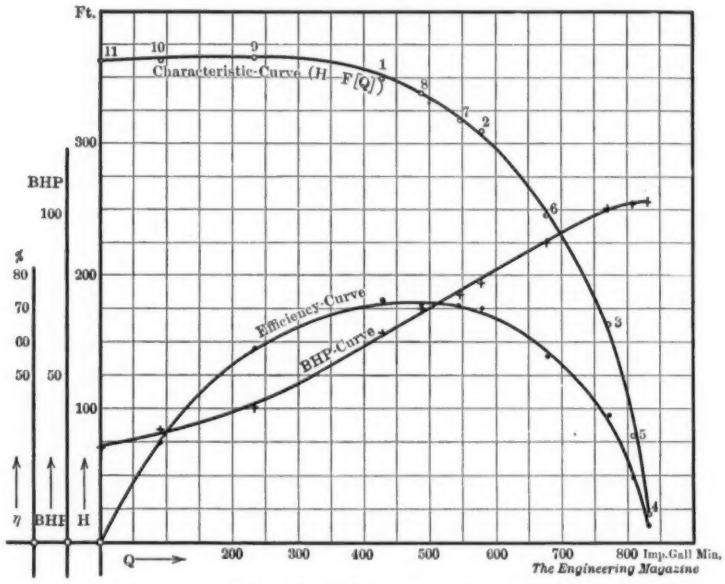



FIG. 35. DIAGRAM OF THREE-STAGE HIGH-LIFT TURBINE PUMP, ACCORDING TO TESTS TABULATED ON PAGES 56 AND 57.
Normal delivery 500 imperial gals. per minute against 335 ft. head.

direct proportion to the number of revolutions, for it needs no argument to prove that a rotor which delivers a fixed quantity per revolution must deliver, per minute, the multiple of this quantity by the number of revolutions per minute. Head, as we have seen, depends solely upon velocity. In accordance with the hydraulic equation

$$H = \frac{c^2}{2g}$$

(c signifying water velocity and g the acceleration by gravity)

it will be clear without much discussion that when rotative speed varies, head will vary proportionally to the square of the velocity of the water, and directly as the circumferential velocity, which latter stands in purely linear ratio to the number of revolutions. Two very simple formulae for reduction thus result.

$$\frac{Q_1}{Q_2} = \frac{n_1}{n_2} \text{ and } \frac{H_1}{H_2} = \frac{n_1^2}{n_2^2}$$

These formulae found by strictly theoretical calculation are altogether supported by practical experience. They permit absolutely reliable calculation for variations of speed. If, for example, experiment shows that a centrifugal pump will deliver 75 gallons per minute to a height of 360 feet at 1450 r. p. m. (point A, Figure 36), the question how much it will deliver at 1500 r. p. m. is answered as follows:

By the first formula above we find that the quantity delivered will be

$$75 \times \frac{1500}{1450} = 77.6 \text{ gallons}$$

while by the second formula above the head to which it will deliver will be

$$360 \times \frac{1500^2}{1450^2} = 385 \text{ feet}$$

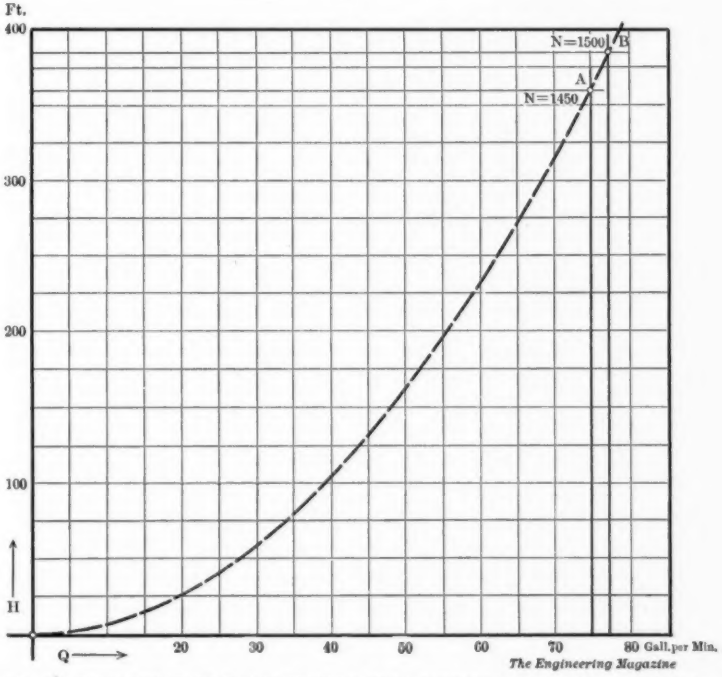



FIG. 36. VARIATION OF HEAD AND DELIVERY WITH VARYING NUMBER OF REVOLUTIONS.

This is shown graphically in Figure 36, B being the point reached by delivery and by head at the higher speed. Figure 37 shows the curves obtained by carrying this calculation through for all the points of the characteristic curve at three different rotative speeds.

These reductions are by no means of mere theoretical interest, nor do they apply only to special cases. Great emphasis should be placed upon the point that the form and variation of the diagram have quite as much importance in the practical operation of turbo-pumps as the question of maximum efficiency obtainable, and possibly they have even more. The following examples will justify this statement.

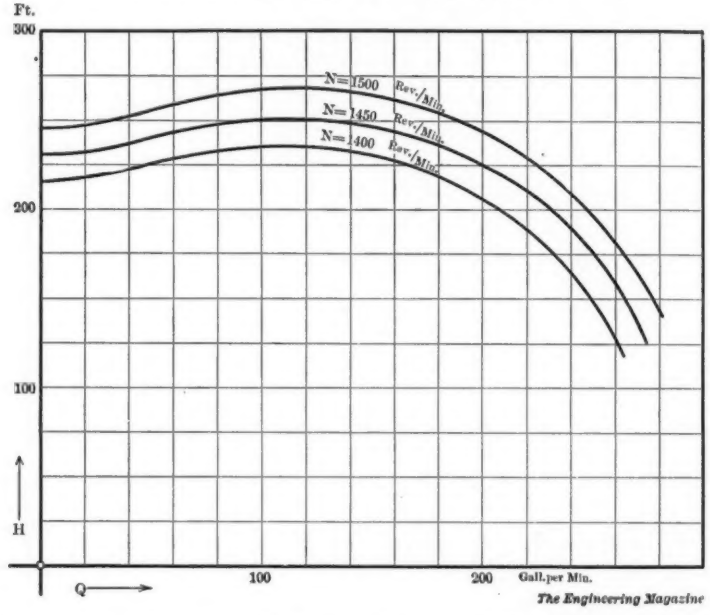



FIG. 37. VARIATION OF CHARACTERISTIC CURVE OF A TURBINE PUMP WITH VARYING ROTARY SPEED.

Figure 38 illustrates schematically mine drainage by turbo-pumps. The pump suction is furnished with a foot valve and strainer 1, while upon the discharge is fitted a gate valve 2 and a check valve 3, which prevents the emptying of the delivery pipe 4 by back flow when the pump is stopped. This discharge pipe 4 carries the water to the surface.

In order to see exactly the conditions which the turbo-pump must meet, we must construct a so-called counter-pressure diagram as

illustrated in Figure 39. When water is raised from the sump to the surface, we must first overcome a purely static head represented by the height of the water column between the level of the sump and the center of gravity of the opening at the surface, $H^1$. If we make this counter pressure an ordinate upon the volume of delivery as abscissa, it will of course be parallel to the axis of abscissas A B, for in mining work this static head is a constant—that is, it remains the same for any quantity of water.

Secondly, the mine-drainage pump must overcome pipe-line friction. This friction of course is zero when there is no discharge (delivery O, point A, Figure 39). It rises proportionally to the square of the delivery, reaching a certain amount, $H_2$, at the normal delivery Q, this amount being calculated by the well-known formulae and coefficients of pipes. The course of this increase will be a parabola. The sum of these two resistances, therefore, is represented by the curve A-$A^1$, which is called the curve of counter-pressure.

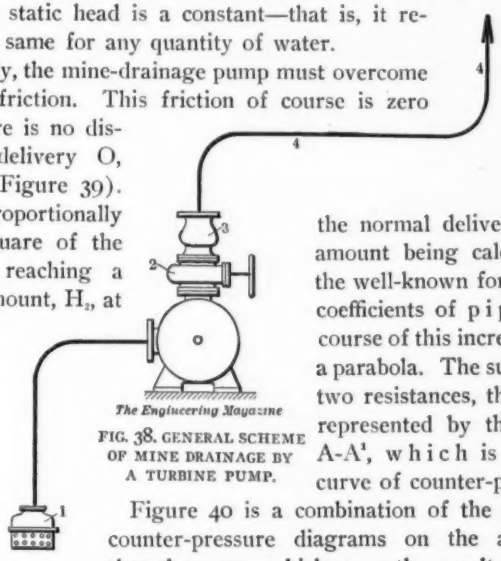



FIG. 38. GENERAL SCHEME OF MINE DRAINAGE BY A TURBINE PUMP.

Figure 40 is a combination of the pump and counter-pressure diagrams on the assumption that the pump which gave the results shown in Figure 35 is installed in a mine 300 feet deep, with a frictional resistance in the delivery pipe corresponding to a head of 18 feet of water column at a delivery of 500 gallons per minute. How this pump when installed can be best started may be understood from the combined diagram. After the pump has been completely filled with water, the gate valve (Figure 38) must be tightly closed. The three-phase alternating-current motor must then be brought up to normal speed. The pressure and vacuum gauges together will then show a pressure equal to 328 feet, supposing 50 circuits of the alternator. When the pump is thus started with a closed gate valve, the advantage is that the motor is not loaded at once with full load, but at first with only 29 brake horse-power. If the gate valve is now opened, the pressure of 328 feet reaching the chamber immediately under the check valve 3 will lift it instantly against the counter-pressure exerted against it by the full delivery pipe.

At this point an important attribute of the characteristic curve may be pointed out. Blade forms are sometimes chosen which give a diagram of which the zero point (N in Figure 40-A) lies considerably below that pressure at which the pump shows its best efficiency (point P). We can see from our combined diagram that pumps

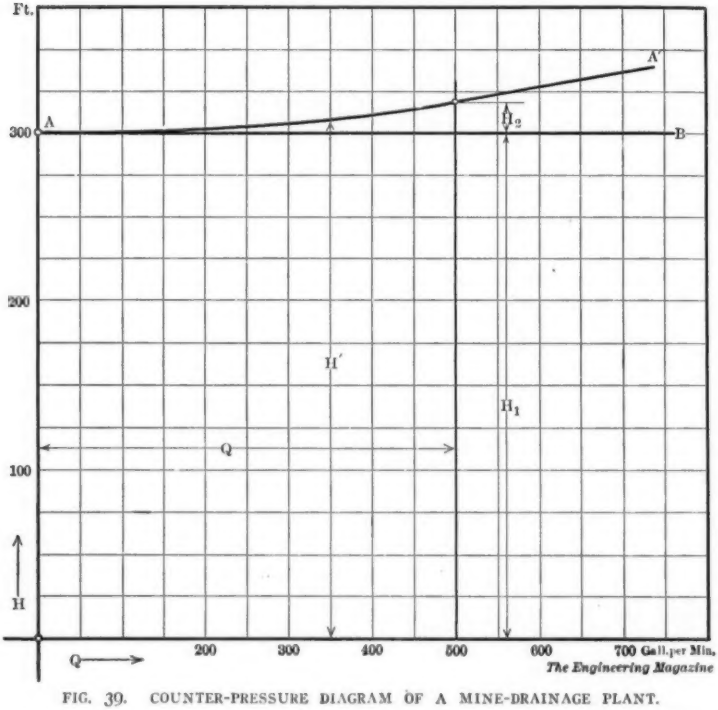



FIG. 39. COUNTER-PRESSURE DIAGRAM OF A MINE-DRAINAGE PLANT.

with impeller blades of this form can not start against a full delivery pipe except by the aid of a special auxiliary arrangement; for when the gate valve is opened the pressure below the check valve will not be sufficient to overcome the counter pressure above it, and the check valve remains closed. Such pumps can not be started except by emptying the delivery pipe to the extent of a column of water of the height N' N (Figure 40-A). Let us return to the diagram shown in Figure 40. When the gate valve is first opened it uncovers only a part of its area and the water is considerably throttled. The throttling resistance is added as a head $H_3$ over and above the counter pressure

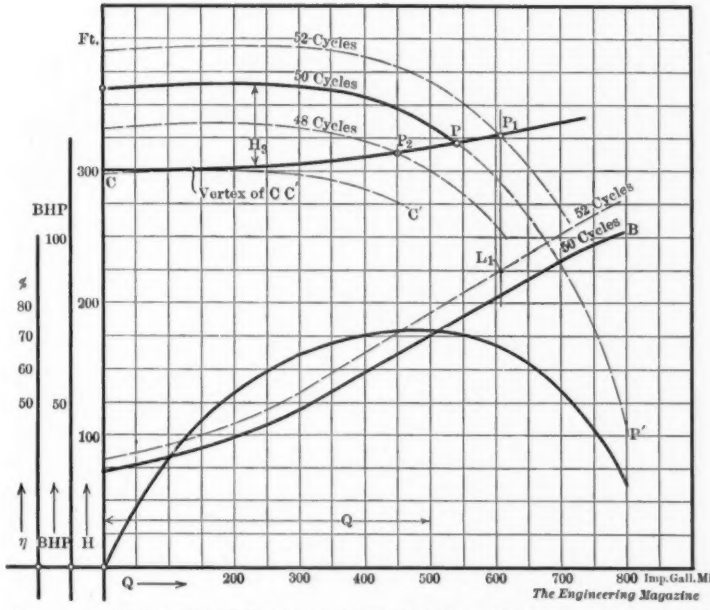



FIG. 40. COMBINED PRESSURE AND COUNTER-PRESSURE DIAGRAM FOR MINE-DRAINAGE TURBINE PUMP.

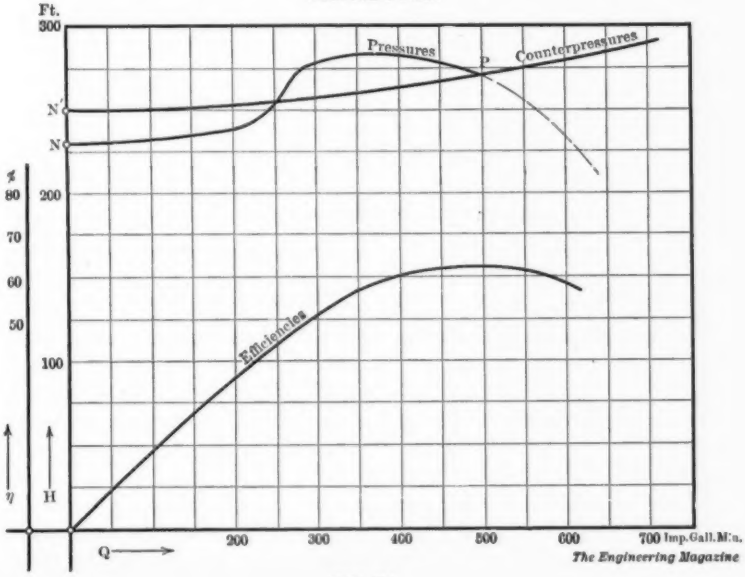



FIG. 40A.

in the delivery pipe. This total pressure can be kept to any desired limit by a corresponding opening of the gate valve *2*, and the pump can thus be made to work at an optional point of its characteristic curve. Let me emphasize that when the gate valve is opened at a regular rate the pump traverses its diagram in regular time. The motor load increases in a correspondingly smooth manner (curve B-B), the movement of the water column in the delivery pipe is gradually accelerated, and all dynamic processes take place as smoothly and as favorably as possible both for the electric and the mechanical part of the equipment. If the gate valve is finally opened wide the difference $H_3$ between the pump pressure and counter-pressure is reduced to zero and the pump works on the point P of its characteristic curve, the pump pressure and the counter pressure to be overcome being in perfect equilibrium without any additional counter-pressure. In contradistinction to the conditions in the testing department, it will not thereafter work on any point of the characteristic curve lying in the portion P-P$^1$; hence follows a result which is of great importance, when a new turbo-pump is ordered for mine drainage. It is customary to order turbo-pumps on the same basis as piston pumps; for example, a pump is required to deliver 500 gallons per minute against a head of 318 feet at 1480 revolutions of the motor per minute, with an efficiency of 70 per cent guaranteed by the makers. The requisite power is calculated to be.

$$\frac{500 \times 318 \times 10}{550 \times 60 \times 0.70} = 69 \text{ brake horse power.}$$

Allowing an excess of 9 per cent, which the miner thinks large enough, a motor of 75 brake horse power is chosen. What would be the consequences if such a tender were construed strictly according to the precedent of the piston pump? The customer would get a pump conforming strictly to all his conditions only if the manufacturer constructed it so that its characteristic curve ran exactly through the point of 500 gallons per minute at 318 feet head. The pump we used for illustration delivers 500 gallons against a head of 335 feet. This means considerable advantage to the mining engineer. The margin of 17 feet insures that even after wear and tear has occurred, or when in the course of years the pipe area is diminished, the pump will still deliver its 500 gallons per minute. Nevertheless, the manufacturer while thus looking only after the true interests of his customer, may get into trouble. It is of course most economical to let the pump run with its discharge valve wide open, for all throttling head is loss. The

pump then works on the point P. It delivers 540 gallons per minute instead of 500, but it uses 75 brake horse power, though the efficiency surpasses the guarantee by only 2 per cent. In spite of the margin of 9 per cent excess provided, the motor is loaded to its normal limit and there would seem to be good reasons for reclamation by the customer.

No doubt a more correct way of ordering would be to specify two limits between which the delivery must lie if the pump works against a certain head, with a certain guarantee of efficiency which must be reached. Above all, it may be learned from this that ample surplus power in the motor should always be provided. Such provision will avoid the necessity of working with a throttled discharge valve—that is to say, uneconomically, and this is not the only advantage. Furthermore, the danger of motor heating with low voltage is lessened. And, beyond all this, it should be noted that variations of rotative speed will cause grave difficulties if a motor of scant power is selected.

The influence which variations in speed exert on a mine-drainage proposition may easily be traced on the combined diagram, Figure 40. If, following the method explained in the case of Figure 37, we draw characteristic curves for 48 and 52 cycles (as dotted in on Figure 40) we see that when the speed of rotation varies the point P travels along the counter-pressure curve to the limits $P_1$ and $P_2$, the discharge valve being fully opened. Increase of rotary speed has the disadvantage that the capacity increases to a much greater extent than with piston pumps, where it rises only proportionately. At the same time the efficiency falls comparatively fast at greater delivery, so that in total the motor must work at considerable overload. For example, in Figure 40 the exact overload for the point $P_1$ is found at $L_1$. From this we can see how powerful a motor must be chosen if eventually 52 cycles instead of 50 were to be expected for any length of time and throttling of the discharge valve were not advisable.

The results which ensue if the number of revolutions falls are particularly worthy of note. The point $P_2$ will move further and further toward the abscissa zero, until at a certain decrease of rotary speed the characteristic curve will be transposed into the position $C\text{-}C^1$, only just touching the counter-pressure curve at its vertex. If the least additional decrease in the number of revolutions is made thereafter the pump pressure falls below the counter-pressure, the check valve closes, and the delivery being entirely cut off, the pump pressure goes back to the point C; it "snaps off." It is unable to reopen the check

valve until the zero pressure has risen above the static counter-pressure of the delivery pipe. At that moment the pump endeavors to traverse instantaneously the whole convexity of the characteristic curve about to the point $P_2$. In this process the motor is first loaded with a sudden jerk, and next the sudden acceleration of the water column (which has slowed down in the interval) throws upon the pump a reaction which may rise to more than a ton and may even cause shaft breakages.

Under normal conditions so great variations of speed seldom occur. The best pump-building firms generally obtain pump diagrams admitting speed variations down to —3 per cent. Special precautions must be taken under certain difficult working conditions as, for example, if heavy electrical winding or hauling machines, reversible rolling mills, etc., run parallel with the pump motors in the same system without any artificial regulation. One such precaution is a great surplus of head in the characteristic curve itself, the convexity of this curve being especially high. Such diagrams, however, require the use of special impellers, which have another peculiarity in that they do not force the water as high per stage as normal impellers. Another precaution may be found in introducing a throttling valve into the delivery pipe so that the zero point of the counter-pressure curve lies considerably lower than that of the characteristic curve or the point of normal delivery. Either bad economy or many stages (that is, high first cost) must then be taken into the bargain. It must be acknowledged that for work in situations where large variations of tension in direct current, or of periods in alternating current, are permanently unavoidable, tubo-pumps should not generally be selected.

Returning once more to the diagram Figure 40 A, we may easily see that pumps with diagrams of such form would create intolerable operating conditions in the case of large speed variations; for having once snapped off, these pumps still can not furnish a zero pressure higher than the static counter-pressure even after the normal speed of revolution is regained. Here again a part of the delivery pipe must be emptied. As it is generally a characteristic of these large speed variations that they occur periodically, another drop in the number of revolutions may cause the pump to snap off again immediately after it has been brought up to delivery with so much trouble. This hint will serve further to show that the form of the characteristic curve is of the utmost importance. It is true that such pumps, although they are generally inferior also hydraulically, nevertheless by the selection of suitable impeller diameters may be made to work to

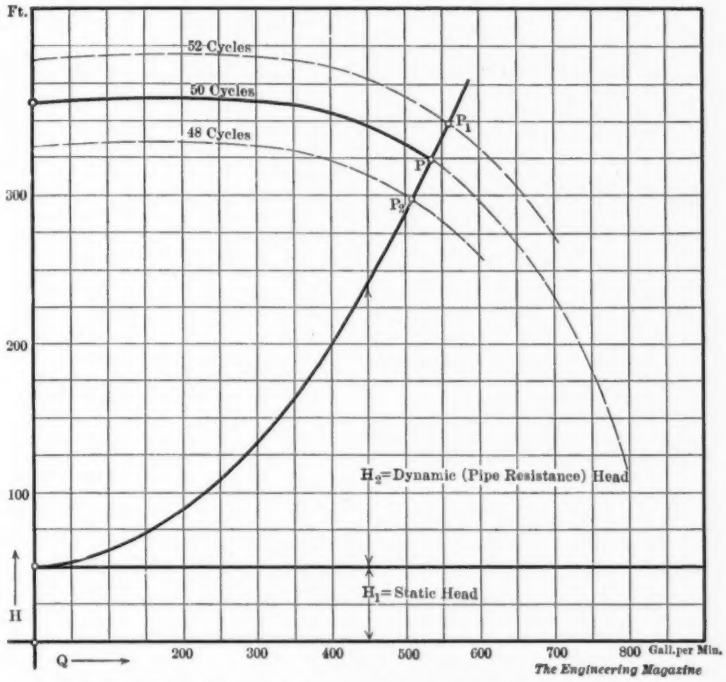



FIG. 41. COMBINED PRESSURE AND COUNTER-PRESSURE DIAGRAM FOR WATERWORKS TURBINE PUMP PLANT.
Three-phase alternating-current motor, 50 cycles.

quite acceptable mechanical efficiency. The form of their characteristic curve, however, betrays them as difficult in operation, at least for the purposes of mine drainage.

For other working conditions, however, these speed variations are quite harmless. This may be illustrated by the example of a waterworks plant. Figure 41 shows the combination of a waterworks counter-pressure diagram with the diagram shown in Figure 35. The base of the counter-pressure diagram here appears much altered. Let us suppose conditions quite usual with municipal water supplies—that is, that water is to be raised from a distant place to a reservoir within the town. The static head may be very small, perhaps even negative if the level of the pumping plant is higher than the reservoir. The counter-pressure results almost wholly from frictional resistance in a long conduit. This, of course, shows again as a pure parabola in the counter-pressure diagram. The point P, where this parabola crosses

the characteristic curve of the pump, indicates the delivery and head when the discharge valve is wide open.

Calculation of resistance in long conduits is extremely difficult because the small errors of experimental coefficients become very important by the multiplication corresponding to the great lengths. Differences equaling one atmosphere of pressure or more may be found if the conduit is a mile or two in length. The counter-pressure can be exactly determined only when the resistance of the conduit is known by gauge readings obtained from pumps already delivering through the same conduit. If such indications are not obtainable, there remains only the uneconomical possibility of throttle regulation if, unfortunately, a motor of insufficient power should be chosen. Speed variations of the driving motors, however, are almost without influence upon the volume of delivery, as shown by the dotted parallel curves on the diagram. Snapping off is not to be feared.

# INDUSTRIAL USES OF REINFORCED CONCRETE.

*By M. M. Sloan.*

## IV. ADAPTATIONS TO STACKS, TUNNELS AND SPECIAL EQUIPMENT.

Mr. Sloan concludes here his series which began in our January issue. It has considered, in concise, practical manner, many important matters involved in reinforced-concrete construction, including general types and special details of industrial buildings and their accessories.—THE EDITORS.

THE uses to which reinforced concrete may be applied in the construction and equipment of power houses and mechanical plants are numerous. Particularly is it of use in the construction of foundations for heavy engines and generators, and in stacks and the flues connections to them. Besides it is much used in the construction of pipe tunnels and conduits.

Some of the largest stacks or chimneys have been erected of reinforced concrete, and while in several instances reinforced-concrete stacks have not been entirely successful, and one or two failures have occured, there are a number of notable examples which seem to give entire satisfaction. It is usual in the construction of reinforced-concrete chimneys to adopt a typical design as shown in Figure 19. The peculiarity of this design over other chimneys exists in the verticality of the sides and the alteration in the diameter of the chimney in the lower and upper portions. The reason for this is the method employed in the construction. There is some difficulty with a sectional form to cast a concrete chimney tapering from the base to the top, it having been considered more economical and more practical to have a form of uniform diameter. As it is desirable in all chimneys to provide them for a portion of the height with an inner and independent shell, it is also necessary to arrange for this shell by increasing the diameter of the stack at the bottom section. Consequently the necessity for the enlargement of the stack in the base and lower section is apparent.

The shells of reinforced-concrete stacks are made a minimum thickness of 4 to 6 inches and are reinforced with steel rings or hoops and with vertical rods or bars wired or clipped to them.

When the stack is made of the design illustrated in Figure 19 it is evident that the construction where the stack changes diameter must

be carefully considered so that there is ample shearing resistance at this point, and the design usually adopted is that shown in Figure 20. It is quite common practise to attempt some architectural treatment for the top of the stack, in the way of a moulded top with bell-cast and fillet as shown in Figure 19.

The place most liable to develop weakness in a stack is at the opening into the stack made for the flue. The design of the stack at this point should be carefully worked out, and the proportion of the flue opening should be such that its width is not greater than one-third of the diameter of the stack. As with openings in any shell, the flue openings should be well reinforced around the edge and over the top so that there is no possible danger of the failure of the stack due to the bending moment of the wind action at the point of its maximum intensity, which is usually at the flue opening.

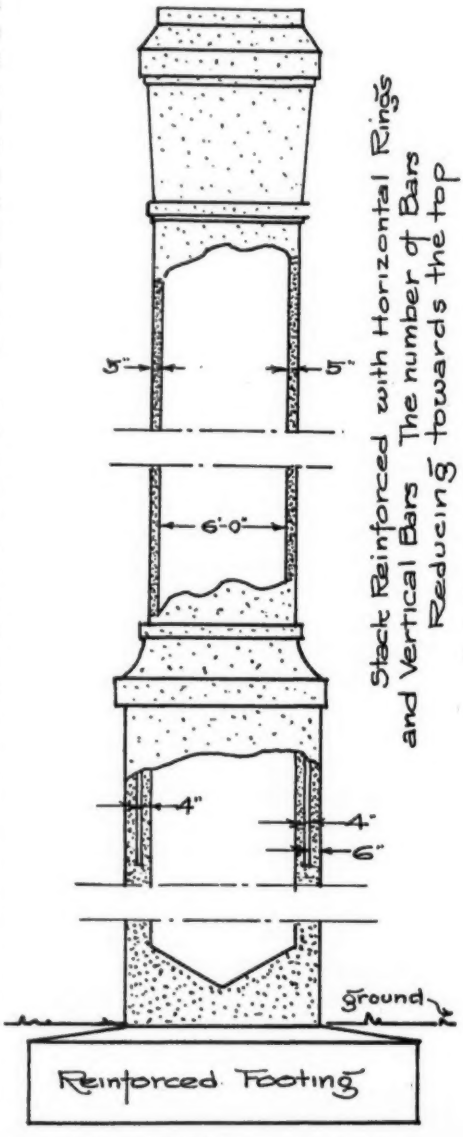



FIG. 19. REINFORCED-CONCRETE STACK.

In the construction of reinforced-concrete stacks, a reinforced concrete spread footing is arranged for their support. As the footing must act monolithically with the stack, reinforcing rods are interlaced with the reinforcing rods of the base and carried up into the shell of the stack as shown in Figure 21. One of the most recently constructed concrete chimneys is illustrated in Figure 23, the peculiarity of this chimney consists in the fact that it is based upon a new principle of construction. This principle consists in using forms of such a type that the chimney, instead of having a straight cylinder, is tapered uniformly from the bottom to the top. A chimney constructed in this manner is more economical in the use of steel rein-

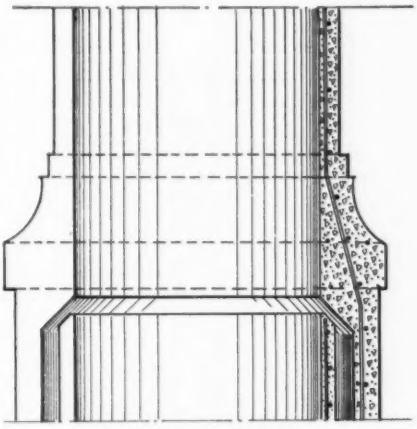


FIG. 20. CONSTRUCTION WHERE STACK CHANGES DIAMETER.

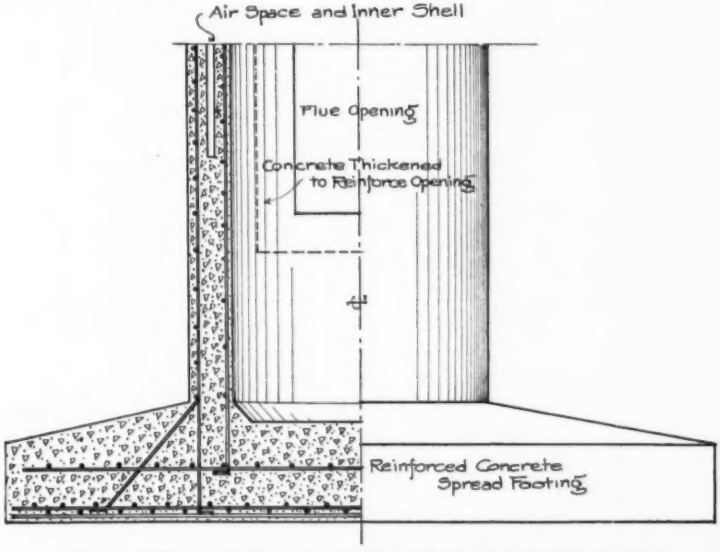



FIG. 21. SPREAD FOOTING AND INTERLACEMENT OF REINFORCING RODS.

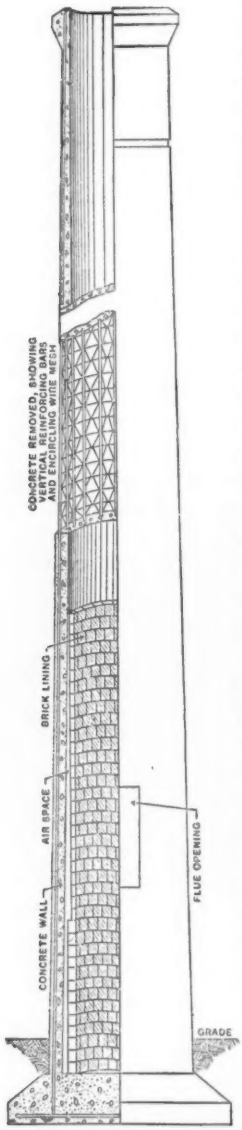



FIG. 22.. REINFORCEMENT TO RESIST THERMAL STRESS.

forcement and has greater stability besides giving a better appearance. The design of a stack of this type is shown in Figure 22. As will be observed from this illustration, the chimney is provided with a brick lining and air space. The reinforcement to resist thermal stress is in the form of wire mesh diagonal type.

An unusual departure in the construction of tapered reinforced-concrete chimneys is in the use of a wet concrete mixture instead of a dry concrete mixture. This insures in the finished chimney a better uniting of the concrete and less likelihood to crazing or cracking. One of the most serious objections to the use of reinforced-concrete chimneys consists in the fact that cement, when subject to intense heat, is dehydrated and the concrete upon examination shows a deterioration of the inner surface, of from one-fourth to one-half an inch. How far this deterioration is apt to continue is problematic, and can only be determined by years of experience.

Reinforced concrete is frequently used in the construction of the base for hollow-tile or brick stacks and a very excellent design for such a base is shown in Figure 24. By the adoption of a base of this kind, ample strength is provided around the flue opening. Sometimes the reinforced-concrete base is lined on the inside with firebrick or hollow tile, and it is in all instances well reinforced both with longitudinal and horizontal rods as illustrated in the figure.

It is quite the usual practise in the planning of eleemosynary institutions to arrange for a central power plant in a separate building, distinct from the others of the group. This is necessitated by the desirability of avoiding the noise or vibration, the dust and danger incidental to a power plant, affecting the administration and the inmates. There-

FIG. 23. REINFORCED-CONCRETE CHIMNEY WITH UNIFORM TAPER.

fore it becomes necessary to provide a means of carrying the wires and pipes from such a plant to the several buildings. This is generally done by means of a tunnel, and this is best constructed of reinforced concrete in the manner shown in Figure 25. The greatest difficulty in tunnel work of this character is due to the fact that the tunnel is quite likely to run through a wet soil, or at some point throughout its length it will pass through a natural drainage basin. It is very difficult to make a tunnel of this character water-

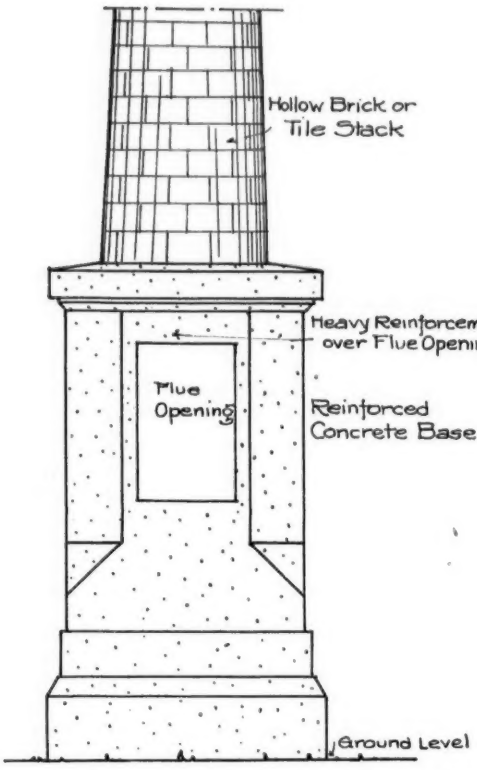



FIG. 24. BASE FOR REINFORCED-CONCRETE STACK.

proof, so that it is best constructed with French drains on the sides so as to intercept any water that may flow through the strata of the soil. In order to provide for any possible leakage through the walls of the tunnel, the floor of the tunnel should be conveniently arranged with gutters on either side as at "a." There is a considerable amount of surface water which should be taken care of by sloping the top of the tunnel as shown at "b" and arranging for it to drip into the French drain. The concrete walls of the tunnel are amply strong if made about 6 inches in thickness, and should be reinforced with longitudinal and vertical reinforcing rods as shown in the figure.

Ordinarily, plain concrete is used in the construction of engine and generator foundations and power houses. There are, however, conditions encountered in the construction of mechanical plants which necessitate the use of reinforced-concrete construction.

It quite frequently happens, especially in old buildings where new units are to be installed, that the engine foundation is quite close to the wall of the building. In Figure 26 is illustrated a reinforced-concrete engine-foundation construction, which was advantageously used where the conditions were unusual. The soil in this particular instance was so poor that it was necessary for concrete piles to be

driven in order to support the engine foundation. It is not possible with ordinary means to drive concrete piles close to a building wall—that is, the centre of the pile must be about 3 feet from the face of the wall. It is evident from Figure 26 that the pile "a" cannot be centered under the outboard bearing. Consequently the engine foundation must be made of reinforced concrete and the depth of concrete beneath the flywheel pit must, when reinforced with the rods or bars "b," have sufficient resistence to carry the cantilever supporting the outboard bearing with its load. As the foundation is in the nature of a cantilever, it is advisable to run anchor rods or bars down into the concrete piles and up into the engine foundation so as to interlace with the reinforcing rods of the cantilever beam. While this type of construction is not recommended, it is the most convenient and available means of constructing a large engine foundation to meet the peculiar conditions existing in this instance. There are several examples of heavy engines running successfully and retaining their alignment on foundations constructed in this manner.

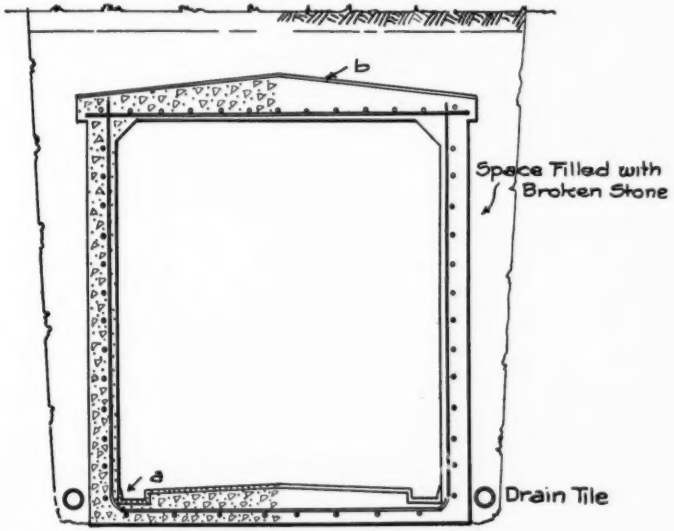



FIG. 25. REINFORCED-CONCRETE TUNNEL.

In a reinforced-concrete building where a belt drive is used from a heavy engine it is customary to provide a reinforced-concrete floor or roof over the engine room. This is the best possible construction because it not only provides an ample protection against fire over the "heart" of the plant, but it also furnishes a rigid construction to which the hangers for the head shaft can be attached.

Where the hangers for the head shaft are secured to reinforced-concrete beams or girders, it is best to use some other means of fastening than the usual sockets. Generally the best practice is to provide pipe sleeves through the concrete, and use "through bolts" with heavy plate washers.

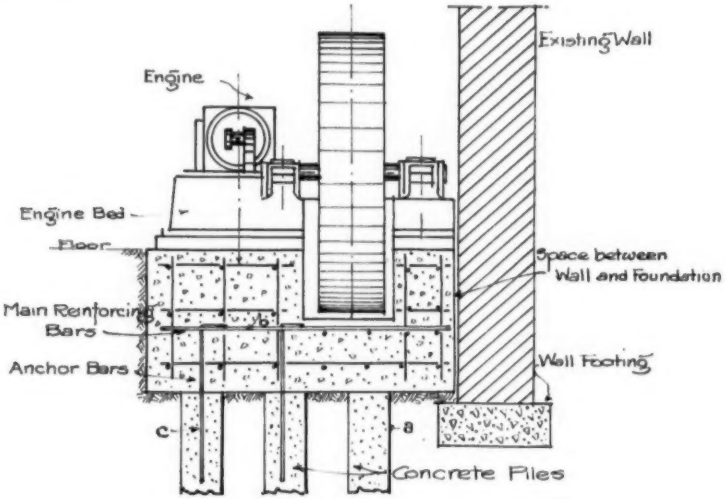



FIG. 26. REINFORCED-CONCRETE ENGINE FOUNDATION.

Reinforced concrete is also extensively employed in power-house construction work, in the construction of coal bunkers and storage bins and also in concrete tanks and reservoirs; as well as hot wells and sump wells. These are usually well reinforced and are generally made waterproof by mixing, in the mass of the concrete or in the surface finish, a waterproofing compound. In the better class of work, a surer means of waterproofing is employed such as a diaphragm of asphalt with a protecting lining.

In all instances, it is advisable where possible to take the additional precaution for making the walls of the tank or reservoir waterproof by puddling the back of the walls with clay.

Reinforced-concrete construction has advanced to a place of importance in power-house work and is used more extensively to supplant other types of construction, for foundations of machinery of a building as well as in the auxiliary appliances such as coal bins, ash tunnels, and hoppers which are of such importance in modern power-house work.

# ORGANISATION BY PRODUCTION FACTORS.

*By A. Hamilton Church.*

## VII. COSTS IN RELATION TO THE FINANCIAL BOOKS.

In the first article of the series, which appeared in our October issue, the author defined his purpose. It is to avoid the uncertainties and errors of averaging and apportioning a general expense account, by recognizing from the outset all the important factors in production—many of them, in his view, quite as distinct and determinable as the wages factor—and reducing them to unit values which can be directly applied to the product they serve. The first paper was devoted to "The Definition of Factors other than Labour," the second to "Production Factors as Related to Cost Accounts and Staff," the third to "The Elements of the Land Factor," the fourth to "Buildings, Heating and Ventilation, Stores, and Organisation," the fifth to "Apportioning Indirect Expense by Production Factors," and the sixth to "Control Accounts." The present installment concludes the argument.—THE EDITORS.

THE final court of appeal in all factory accounting is, or should be, the financial books, which bring their record of operations to a focus in three final accounts—the Trading Account, the Profit and Loss Account, and the Revenue Account. Manufacturing costs, whether interlocked with the financial books or treated as entirely separate and subsidiary, should be regarded as an attempt to present an amplification and detailed explanation of the condensed figures set out in these final accounts.

Generally speaking, these accounts deal with three different aspects of profit, viz;— (1) gross manufacturing profit, (2) net trading profit, and (3) disposal of profit in dividends, etc. These accounts are sometimes called by other names, as for instance, Manufacturing, Trading, and Profit and Loss, instead of Trading, Profit and Loss, and Revenue; but however styled, the functions of the three final accounts are, generally speaking, substantially as above stated.

The three specimen accounts given will serve to show the usual scope of each. In the first one it will be seen that by setting the value of stores and work in hand at the end of the financial period against their value at the beginning of the period, plus the amount of stores purchased and wages paid, we virtually ascertain how much the total value in hand has increased or diminished since the last stock-taking. It will usually be found to have diminished by reason of deliveries effected, and it will be obvious that if we were to credit the account

| Dr. | TRADING ACCOUNT | | Cr. |
|---|---|---|---|
| Work in Hand at beginning of period | $ 10 000.00 | Work in Hand at end of period | $ 10 426.00 |
| Stores " " " " " " | 3 000.00 | Stores " " " " " " | 2 801.00 |
| Purchases during period | 2 876.00 | Sales during period | 25 103.00 |
| Wages paid during period | 11 813.00 | | |
| BALANCE = Gross Profit for period | 10 731.00 | | |
| | $ 38 420.00 | | $ 38 420.00 |

| Dr. | PROFIT & LOSS ACCOUNT | | Cr. |
|---|---|---|---|
| Repairs & Maintenance | $ 400.00 | Gross Profit from Trading A/c. | $ 10 731.00 |
| Interest & Depreciation | 1 020.00 | Discounts taken | 50.00 |
| Rents, Taxes & Insurance | 130.00 | | |
| Management & Supervision | 300.00 | | |
| Office & Selling Expenses | 2 300.00 | | |
| Packing & Freight | 400.00 | | |
| Discounts allowed | 50.00 | | |
| BALANCE = Net Profit for period | 6 181.00 | | |
| | $ 10 781.00 | | $ 10 781.00 |

| Dr. | REVENUE ACCOUNT | | Cr. |
|---|---|---|---|
| Interest on loan Capital | $ 1 290.00 | Net Profit from P.& L. A/c | $ 6 181.00 |
| Legal Expenses | 121.00 | | |
| Directors Fees | 200.00 | | |
| Reserve Fund | 1 600.00 | | |
| Dividend for Period | 2 970.00 | | |
| | $ 6 181.00 | | $ 6 181.00 |

*The Engineering Magazine*

In engineering works, additions to plant and repairs to tools, buildings and plant are frequently carried out by the shops. In such cases the value of the work would be credited to trading account. In the accounts above and in the discussion following it is assumed for simplicity that a purely manufacturing business is done in the shops, repairs, etc., being contracted for with other firms. The figures given are purely illustrative and do not represent any actual case.

with the *cost* value of such delivered orders, it would exactly balance, and show neither profit nor loss. As, however, the account is credited at *sale* prices it follows that a balance corresponding to the difference between cost and sale price—that is, to gross profit, will appear.

In the second account, the gross profit transferred from the previous account is subject to a process of diminution by setting

against it the indirect charges or establishment expenditure, some of which are really costs of production and some are charges arising from selling and distributing the product. The long established practice of collecting all these into the same account has given rise to much of the confusion that surrounds the question of charges, especially in the matter of distinguishing between shop and general charges. The third account deals only with the disposal of profit and not with how it was made. It does not need further consideration at the present moment.

The reason why Trading account is arranged as it is will be clear when we remember that very few auditors have any faith in the apportionment or distribution of charges, and prefer to deal with figures which have the merit of being definite, as the direct expenditure on wages and materials usually is, and to set against these the equally definite figure of sales—the difference between the two representing, it is true, no complete fact, but giving, nevertheless, a relation of well understood significance, viz:—gross profit.

It should be observed, that for financial purposes it is not necessary to have any knowledge of what are usually known as costs. It is sufficient to know the sale price of each order, and when all these are aggregated, forming a total of sales for the period, the difference between values in hand at the beginning of the period and the values in hand at the end of the period (plus what has been put in during the period) gives a net figure which is really equivalent to *the prime cost of all the orders in a lump sum.*

To ascertain profits, therefore, it is not necessary to know individual costs, but only individual sale prices, if a stock-taking valuation is taken at the beginning (or end) of each financial period. This ascertainment of results in the lump at the end of a year or half year is still relied on by many firms.

But just as the figure representing total sales is an aggregation of a number of individual sales, so the balance representing cost of orders is really an aggregate of a number of individual costs. If therefore an accurate system of prime costs is in use, the trading account could be very simply checked by making a list of all orders which have been completed and invoiced and placing the prime cost against each. It is clear that this list, if set against a list of the sale prices, would show a difference that would be identical with the gross profit exhibited by the trading account.

In the same way, if a perfect system of distributing all the indirect charges incurred in production were in use, and a list were to be prepared of all delivered orders showing:—

1.—Their prime cost . . . wages and materials.

2.—The indirect shop charges.

3.—A due proportion of general and selling expense, then the aggregate of these items for all orders completed and delivered, when set against the sale prices, would show a difference or balance exactly corresponding to the net profit shown by the profit and loss account.

We are now in a position to realise what an entirely different procedure is commonly undertaken with regard to presenting the details of these two great divisions of manufacturing cost represented respectively by these two accounts. No one has ever suggested that prime costs should be averaged. No one ever argues that if $200 has been spent on $20 articles, then the cost of each can be safely considered at $10, unless indeed the product is absolutely uniform. Such a suggestion would be treated with ridicule, because obviously the only use of detailed costs is to reveal the *relative* amounts of wages and material that the different orders have absorbed. The incidence of labour-cost and material-cost on orders is too obviously individual and unequal for us to think of averaging prime costs.

When, however, we come to the second and third elements of cost, which form the subject-matter of the profit and loss account, an entirely different plan is commonly pursued. Notwithstanding that the expenditure under this head frequently equals and sometimes surpasses in value the item of wages which are generally so carefully traced and allocated to individual orders, it is a very usual practice to average this large class of expense, and to express its incidence by a simple percentage either upon wages or upon time.

That this plan is entirely misleading there can be very little doubt, because few of the expenses in the profit and loss account have any relation either to each other or to wages or to time. To rely upon an arbitrary established percentage which may actually be either much over, or much under, the real incidence of a number of varied factors on a particular order, may be a good way of getting rid of figures and giving an air of finality to cost accounts, but it is very little else. As a guide to actual profitableness of particular classes of work it is valueless and even dangerous.

If, however, the greater part of indirect expense could be reduced to a *real* incidence on particular jobs, we should find ourselves at once in presence of new and important classes of facts. Foremost amongst these is the question of inefficiency due to idle manufacturing facilities, or as I prefer to call them, "Production Centres." Whether such production centre be a machine, a pattern maker's bench, or a plain floor area in an erecting shop or a foundry, it is obvious that if it be idle

and unoccupied in production, money value is as surely being wasted as if wages were being paid to a number of men who were entirely unoccupied. To allow the incidence of such wasted resources to become attached to work by means of an averaged percentage, on whatever basis the latter is calculated, is grotesque in its inadequacy to represent actual facts.

Nor is it less absurd to include selling expense in the same percentage with manufacturing expense. The two have no relation to one another whatever. The routine, the methods of selling, and the expenditure on different classes of articles may and often do vary considerably. It may easily happen that the efforts and the expenditure to obtain business in particular lines are so great that the result is not by any means worth the trouble. How is this important fact realised by any plan of averaged percentages? If such facts, and those just referred to (idle production centres) are not brought out separately and distinctly, it may well be asked,—what is the use of an averaged percentage at all? The answer is that in certain very limited conditions it is of value, but that where more than one class of article is being manufactured it becomes merely a remarkably intricate device to give misleading information.

The proper relation of costs to the trading account and the profit and loss account may now be summed up. These two accounts give results *in bulk*. Prime costs are the details of labour and materials on the individual orders, which have passed out of trading account by reason of sales. Complete costs *should be* the prime cost plus the accurately detailed incidence of shop charges, general charges and selling expense, also on each individual order. Manufacturing cost plus selling cost should, then, contain several separately expressed factors as follows:—

1.—Prime cost . . . wages and materials.

2.—Shop burden, which will include a proportion of general or administrative expenses.

3.—An inefficiency factor, or supplementary rate, representing loss of efficiency due to idle production centres and wasted facilities of manufacturing.

4.—Selling expense (also including a proportion of general or administrative expense) based on the actual absorption by each *class* of product, of the different items of selling expense.

It will probably be objected that this is a very complex and formidable way of presenting costs. The answer is that in actual practice it is not as difficult as it looks, but a still more complete reply to the objection is that no method that fails to provide the information in

this detailed form is anything more than a sham. *No facts that are in themselves complex can be represented in fewer elements than they naturally posses.* While it is not denied that many exceedingly complex methods are in use that yield no good results, it must still be recognized that there is a minimum of possible simplicity that cannot be reduced without destroying the value of the whole fabric. The snare of the "simple system" is responsible for more inefficiency and loss than is generally realised.

Work accountants would be better able to realise this point of view and enforce it on those to whom it is a matter of importance, if, instead of collecting all items of indirect expense into profit and loss account, they were to divide the latter into two accounts, thus providing an intermediate account between gross profit and net profit. (See specimens opposite). In such case trading account would contain prime cost only; the new account, which might be called net manufacturing account for want of a better title, would correspond with elements (2) and (3) of cost, while profit and loss account would correspond with element (4). The items given in the specimen accounts will explain this disposition, the only special point being the division of general and administrative expense between the shops and the selling department on an adequately thought out basis.

Arranged in this way the place and position of each of the elements of cost in relation to the final accounts is clearly seen, and also the utter inadequacy of "simple systems" to represent all these different factors. It may even be said that a measure of the success of any system of collecting costs is thus provided, because complete agreement with these accounts at each stage must be insisted on as a means of verifying the accuracy of cost figures.

### Selling Expense.

The true relation of selling expense to production can be grasped most effectually by picturing the works and the selling department as being located in different places. With the former in the country and the latter in a more or less distant city the relation is at once seen to be perfectly simple—namely, that there is no relation at all! From this consideration it is not very difficult to realise that the mere fact of their happening to be located in the same place or in near neighbourhood does not make their mutual relations any more intimate.

It is the more important that this fact be fully realised since the types of selling organisation are far more varied than those of manufacturing organisation. Even in the same concern some of the product may be on an entirely different footing as regards selling expense from other items. For example, a large section of the business may

| Dr. | TRADING ACCOUNT | | Cr. |
|---|---|---|---|
| Work in Hand at beginning of period | $ 10 000.00 | Work in Hand at end of period | $ 10 426.00 |
| Stores " " " " " " | 3 000.00 | Stores " " " " " " | 2 891.00 |
| Purchases during period | 2 876.00 | Sales during period | 25 103.00 |
| Wages paid during period | 11 813.00 | | |
| BALANCE = Gross Profit for period | 10 731.00 | | |
| | $ 38 420.00 | | $ 38 420.00 |

| Dr. | NET MANUFACTURING ACCOUNT | | Cr. |
|---|---|---|---|
| Indirect Expense in Shops: Interest, Depreciation, in Shops | $ 930.00 | Gross Profit from Trading A/c. | $ 10 731.00 |
| Indirect Expense in Shops: Repairs & Maintenance in do. | 350.00 | | |
| Indirect Expense in Shops: Rents, Taxes & Insurance in do. | 96.00 | | |
| Indirect Expense in Shops: Other Shop Expenditure | 100.00 | | |
| Proportion of Administration Expense* | 306.00 | | |
| BALANCE = Net Manufactoring Profit | 8 949.00 | | |
| | $ 10 731.00 | | $ 10 731.00 |

| Dr. | PROFIT & LOSS ACCOUNT | | Cr. |
|---|---|---|---|
| Selling Expense: Travellers & outside staff | $ 1 160.00 | Net Manufacturing Profit | $ 8 949.00 |
| Selling Expense: Advertising, Catalogues &c | 400.00 | Discounts Taken | 50.00 |
| Selling Expense: Packing & Freight | 400.00 | | |
| Selling Expense: Sales Dep't staff | 600.00 | | |
| Discounts allowed | 50.00 | | |
| Proportion of Administration Expense* | 208.00 | | |
| BALANCE = Net Profit | 6 181.00 | | |
| | $ 8 999.00 | | $ 8 999.00 |

| Dr. | REVENUE ACCOUNT | | Cr. |
|---|---|---|---|
| Interest on loan Capital | $ 1 290.00 | Net Profit from P.& L. A/c. | $ 6 181.00 |
| Legal Expenses | 121.00 | | |
| Directors Fees | 200.00 | | |
| Reserve Fund | 1 600.00 | | |
| Dividend for Period | 2 970.00 | | |
| | $ 6 181.00 | | $ 6 181.00 |

*The Engineering Magazine*

Administration expenses consist of office rents, staff salaries, management expenses, and similar items common to the manufacturing and selling departments and not separately allotable to either. Compare these accounts with those on page 78.

consist of a standard product for which there is a steady demand, arising from the reputation of the firm for that product, and requiring no special and expensive efforts to secure business. Another portion may consist of a specialty, recently introduced, and taking a large amount of time, attention, advertising and demonstrating expense, installations on appproval, etc., to effect sales.

It will be evident that any method of dealing with selling expense must distinguish between these two classes of sales, and not average the total selling expense over total sales. In other words, selling expense must be dealt with by classification of product, having in view, not the difference in cost of manufacture but difference in calls on the expenditure of the sales department. All product should be debited to the sales department at works cost—what happens thereafter is no concern of the productive departments, and the figures relating to the two classes of activity should never be mingled. The principle of "keeping separate" is as important here as in all other branches of technical accounting.

As these articles are intended to deal only with production, the question of selling expense cannot be further enlarged upon, the subject being a large one and deserving separate treatment. It will be sufficient for our present purpose to emphasise the principle that production expense ends at the works gate. In the sample accounts presented here, it will be observed that selling expense is groupd by itself in the profit and loss account. This is as it should be, because it represents a wholly different class of activities which require to be dealt with on their merits. Manufacturing and selling call for the exercise of quite different faculties, rarely found combined in the same individuals.

### Summary of the Production Factor Method.

The method of organisation by production factors and their connection with production centres has now been outlined. We have seen how a considerable number of items hitherto considered as indirect or floating charges are really possible of consideration as in the nature of rents chargeable against production centeres, and thence passing out onto the work performed by those centres. We have seen that production is made up of services, of which labour is only one. And we have also seen that inefficiency due to slack production can be expressed as a separate factor of cost. Further, we have seen that selling expense is not reducible to the same basis as production, but that it has laws of its own that cannot be neglected.

It will be obvious that costs developed on this plan are a more subtle engine of discrimination than any hitherto available. The

production-factor method gives free and independent play to the various elements of cost in a manner that is not possible of realisation on any method that first drags heterogeneous expenditure forcibly into lump sums, and then deals with these as if the only object were to get rid of them on work—no matter how, as long as they are got rid of. On the contrary, we have seen that each production centre bears its own burden, and pays its own series of rents quite irrespective of what its neighbour is bearing, and this without reference to whether the shop is slack or busy. Further, the effect of waste of factors, as for instance a shop only half full of tools, or in which tools are unnecessarily and wastefully isolated, shows itself as a separate element of cost, or rather it goes to swell the supplementary rate which is to a considerable extent an inefficiency element of cost.

The control over the form of costs obtained under the system of organisation by production factors, though important, is not the only, or perhaps even the greatest, benefit attained by this method. The point of view from which production necessarily becomes regarded is an even more important matter. A clearer insight into what manufacturing really implies is gained when we begin to look at a works or factory as an assembly of centres each absorbing special services or "production factors" independently and unequally. We come to regard a machine, not as a mere inert piece of ironmongery but as a kind of living entity having as nearly definite a price as the work of an operative has a definite price. This price moreover is no arbitrary one, but is compounded of a number of separate and independent factors, which it is possible under certain circumstances to vary and reduce.

The modern plan of laying out everything as far as possible in advance, of predetermining results, and of rigorously comparing what has taken place with what was expected to take place, has a close relation to this form of organisation. Until the idea of planning became familiar, the idea of mapping out the activity of a complex factory in definite production centres would have seemed impossible of attainment. And it is equally true that this method of organisation reacts in no feeble way on the possibility of predetermined results of actual manufacture, since it permits every extension and every rearrangement to be reduced in advance to figures—definite, not as affecting particular groupings of indirect charges, but as bearing on the hourly work of every single machine or production centre.

The most noticeable tendency in engineering manufacture at the present time is a desire to reduce all operations to definite standards. "The machine-shop problem" as Charles Day said recently in these

pages* "in its most elementary sense, resolves itself into one of removing chips from the parts on which work is to be done." And in this direction "shop practice is nearing a stage approaching standardisation," largely because "the records that have been secured and the standards that have been established by machine-tool builders and the concerns manufacturing tool steel are now so complete that their maximum capabilities can be foretold within reasonable limits."

These developments are part of the general progress towards regarding manufacture as a step by step series of definite predeterminable operations—a tendency that cannot be fully realised until the vague incidence of indirect charges is, once for all, got rid of and the maximum and minimum range of incidence on definite production centres substituted for it. When along with the "chip-removing" capacity and power absorbtion of every different type of machine we begin to realise that it has a natural machine rate, which can be forecast within certain limits even before it is actually installed in a shop, a good step forward will have been made in the direction of final standardisation. Only the accumulation of records and of compared experience can make this possible, but it will be allowed that *a general acceptance of the principle of organisation by production factors would have the effect of making known the usual or standard values of such factors under conditions of good practice,* and that therefore as soon as the elements of cost, power, durability, space, and attendance of any new machine were determined, *its normal rate under conditions of efficient and economical installation and working would also be predeterminable with sufficiently close accuracy.* In so far as such theoretical rates were not realised in actual practice it would suggest a prima-facie case for enquiry into causes.

It may be objected that these factors are subject to change. That is their merit. The belief in the possibility of a simple system, that once established, will give accurate results for all time, is based on sheer inappreciation of the problem. In a works undergoing changes and modifications the actual factors of production are constantly being varied, *whether we wilfully shut our eyes to the fact or not.* The merit of the production-factor system is that it provides a method of quickly taking note of such changes and allowing their influence to become manifest, instead of ignoring them, and dwelling in the false security that changes of manufacturing method have not shifted the incidence of factory burden. Every such change does so, and just how far and what direction it works is a very important matter.

*"Machine Tool Practice for Maximum Production," in THE ENGINEERING MAGAZINE for July, 1909.

When someone unfamiliar with manufacturing is taken into a machine shop, his impression is that of a wonderful activity of which he can discern neither the plan nor the guiding strings. Those having an inside knowledge based on older methods of organisation are not as much advanced beyond this point of view as might be imagined. The shop presents itself to them as a number of machines and a number of men, it is true, but they can only picture a very limited portion of the total activity as definitely connected with work performed. This portion is represented by the hourly wages of men actually engaged on orders; all the rest of the activity and all the rest of the expenditure, seen and unseen, is blurred into a vague and indefinite perception and lost in the mists of "indirect expense." The narrowing down of indirect expense to close association with production centres is therefore not only important from the point of view of costs, but promotes clearer ideas of organisation and helps to answer in a very definite way the ever pressing question "where all the money is going to."

As has been alreay referred to in these papers, one of the obstacles to a clear view of the true relation of indirect charges to work has been their *continuous* character. Whether work is being done, or not, the larger portion of such charges have to be met, if not out of profits, then at the expense of capital. Unconsciously the argument is made that if these charges are always pressing on the undertaking whether work is being done or not, then they cannot have any real connection with particular items of work. But *what is really being paid for is the capacity to produce,* and whether that capacity is being wasted or not it still has to be paid for either out of profits on the unwasted portion or out of capital. When, however, we do employ that capacity it seems fairly obvious that the cost of the portion employed passes into the work done as an element of job cost.

In this connection it must never be forgotten that the "Supplementary Rate," the moment it rises above the normal, represents shop inefficiency. It represents that portion of the cost of the job which is due to abnormal conditions. By expressing this amount separately, we disentangle true costs from apparent costs in a way that has never before been possible. In other words, the supplementary rate is closely identified with the continuous character of indirect charges, and it overcomes the obstacles to a clear view of their true relation to work just spoken of. The utilised capacity of production centres passes into the ordinary cost of the work, the unutilised or wasted portion flows into the supplementary rate, and becomes a memorandum of the inefficient conditions prevailing. A high supplementary

rate represents wasted opportunities and nothing else; its expression as a percentage on work is only a matter of convenience, for the purpose of a danger signal. It consists, in fact, of that portion of the indirect charges which if not dealt with in this way, would remain to the debit of profit and loss account. Either as part of costs or as a balance on the wrong side in the accounts, it signifies unemployed capacity for production. It is distributed over work done only because its significance is more easily recognised in that way than if it were left as an undistributed debit balance. Further, it is thus brought to the notice of officials who have no access to the accounts.

If there is one thing more than another that seems to require emphasising at the conclusion of these articles, it is the need of regarding costs as having an intimate and vital relation to the financial accounts. The requirements of accountants and of technical officials differ so much that each is apt to go to his own way and pay little attention to the other's work. As a matter of fact, costs can be more intelligently understood, particularly as regards their relations with indirect charges, if they are regarded as the separate items from which the financial accounts are built up. To speak technically, the latter are the control accounts and the former are the detail accounts which ought to correspond completely and absolutely. The doctrine of unemployed capacity set out above has been developed not from the shop side, but from a review of the elements of profit and loss. During this examination it was observed that where charges due to the activity of production centres were alone made part of costs, a considerable balance remained if the shops were not employed to their full capacity. That this balance represented wasted capacity of production *and was in fact the price paid for that waste* was presently seen. This instance is given to show how pure accountancy can be made to throw light on manufacturing problems, for it is certain that a study of costs as costs would never have brought this important fact to light.

Lastly, emphasis must be laid on the fact that there can be no such thing as "simple" systems of cost. There cannot be less than five elements in any true cost, all of which must be expressed separately. (1) Materials; (2) Direct Labour; (3) Machine Rate (which expresses in one figure a number of different and independent incidences); (4) Supplementary Rate, expressing wasted or unemployed capacity; (5) Selling Expense. It is hoped that the arguments put forward in these articles will have served to demonstrate that these five elements have no common ground and cannot therefore be expressed in any other way than quite independently of each other. Any other method must produce figures that are necessarily unreliable, and unsafe.

# IRREGULARITIES IN FURNACE FIRES.

*By Arthur S. Mann.*

**Mr. Mann offers and supports by argument a suggestion which has recently come from several independent sources—the suggestion that competent technical men be placed in direct and immediate charge of the fireroom and its stokers. It is an interesting proposition, and one that our contributor is in position to discuss with authority.—THE EDITORS.**

A FIRE bed is seldom homogeneous. Therefore heat coming from different parts of the fire is not uniform, and the furnace gases must differ in composition for a part of their path toward the breeching. There is indeed no certainty that they ever become uniform in composition.

A large bed of fire, say 10 feet by 8 feet, worked and stoked by hand, depends for its uniformity upon the watchfulness of the fireman. He cannot change the coal, and he can do no better than to see that the fire bed has a thickness approximately even.

The coal itself is a variable. When a sample for analysis is desired, small portions are taken from the car or the storage, pounded up, mixed, and quartered till a workable sample is secured which is representative. The fireman cannot take such pains with his coal. He gets fifteen or twenty pounds on his shovel and throws it into his fire. Volatile matter in excess may and does reach parts already oversupplied, and this is another irregularity added to imperfections in stoking.

Working the fire with bar and rake causes sure and added inequalities, all contributing toward a furnace gas made up not of a uniform mixture, but rather of numerous streams that probably never intermingle. Some time ago a small plant came under my observation. There were two 60 horse-power boilers fed with a single direct-acting pump. The load was steady and the speed of the feed pump could be kept constant throughout the day. The feed valves from the main to each of the boilers were stuck fast from disuse. If the water was a little low in one gauge glass, a barring was given the other fire which brought the glasses even again; and so the plant see-sawed all day.

Now in the case just cited it took only a slight movement of a bar to lower the water. The fire appeared only slightly different after the barring, and it should be added that the fires themselves were only

moderate—quite cool enough to be visible all over. A hole or a thin spot would have been clearly apparent, but a small irregularity would escape unnoticed unless looked for carefully. To be sure, it was not necessary to evaporate the excess water in the boiler showing the high gauge; the boiler had to make only a little more steam than its neighbor, raising its pressure slightly and so offering greater opposition to its incoming feed water.

Another case of this character presented itself in a plant fitted with chain-grate stokers and horizontal water-tube boilers of the Babcock & Wilcox type. The boilers are two-drum, 250 horse-power, with a liberal grate area. The station itself is situated in one of the British colonies and boiler fittings follow British custom. In respect to gauge glasses, each drum has a glass fixed directly to the drum head without water barrels. The boilers themselves were slightly underloaded, about 95 per cent of rating perhaps, and the fires were never forced. The draft was ample and the equipment steamed easily.

It would appear that under the conditions cited the fires would be uniform all over. There is an adjustable gate lying horizontally between the hopper and grate which gives a uniform fuel thickness, and this is set to give a feed proportionate to the load. The soft coal was crushed to 2-inch pieces and smaller, precluding the possibility of a bare spot, and all parts of the fire were subject to the same chimney draft. Despite this apparent uniformity in the fire, the two water gauges in any given boiler seldom showed equal heights of water. Sometimes the difference would be not more than one inch; at others, there would be a variation of nearly 3 inches.

In this instance it is probable that the drum showing the low water had greater steam pressure due to more vigorous combustion on that side. The fires themselves were never touched with a hand tool, so that burning conditions were as uniform as machinery could make them.

A third instance of uneven water occurred in a plant larger than either of the others. The plant itself had been increased by the addition of some five hundred horse-power horizontal water-tube boilers. The furnaces were fitted with a stoker which could carry large overloads. The fuel after once reaching the grate was worked by hand. When the first attempt at forcing these boilers was made, they sent water in large quantities out through the steam pipe. They were all right at regular load and at 30 per cent above load, perhaps. When 60 and 70 per cent overloads were called for the water gave trouble.

These boilers had two horizontal drums. The whole trouble was cured by adding a steam cross pipe in the live-steam connection; but the additional area was required to take care of the excess steam which one side of that fire generated under forcing. Steam velocities were high, but the furnace chamber was not divided in any way. Gas coming from one section of the fire was quite free to mingle with that from other sections. Still the irregularity was very pronounced in development of pressure.

When there are irregularities such as these in a fire; when their presence is known; and when effort is made to improve the defect, and at the same time the imperfections still remain in spite of all available effort, it would appear that like irregularities might exist in a furnace when they were not expected and where no special effort is made to remove the disability. And unless there is a certainty that the furnace gases are thoroughly mixed on their way through the boiler, it would seem impossible to draw conclusions in regard to efficiency of combustion by taking a small sample of gas occasionally from a large thoroughfare. The usual sample is only 100 cubic centimeters. A 500 horse-power boiler gives off 20,000 cubic feet of gas each minute, so that while the volume of sample is being drawn, 3,000,000 like volumes have passed the sampling plant. Without some specially prepared intermixing device, it would seem unlikely that the sample should be even fairly representative, particularly when it is known that the gases start from the furnace with widely different compositions.

It would also appear that if perfect fires are wanted, something better than gas analysis must be the criterion of perfection. There are occasions where a very marked improvement in furnace efficiency is made possible through the use of gas-analysis apparatus, but in such instances it may also be that almost any change in the fire, changing either thickness or air pressure, would have made as great or greater improvement. If efficiency is only low enough to begin with, it is possible to make very liberal improvements. It should be realized that gas analysis is nothing more than a check at best.

I recall acting for the purchaser in some stoker acceptance trials. The inventor of the apparatus was present in his overalls, and he had a very able fireman as assistant. The fireman was fairly busy in caring for the needs of the furnace. The inventor was active in watching the fire itself. He depended upon the way the fire looked, on top and underneath. It was "Jim, just check that draft for a few

minutes;" "run your bar down this side;" "give a little more action on that end;" "check that feed a little;" and so it went all day. The two could have cared for more stokers, to be sure, but they both felt that burning coal called for an active head. The actual evaporation was nearly eleven pounds. No attention was paid to the flue-gas analysis. The man managing the fire did not need that sort of a crutch. Some analysis were made, however, for a matter of record. The best examination a fire can have is made with the eye. If the grate is flat something can be learned from a rake and slice bar, but the man who expects to do well in the fireroom must know what a good fire looks like, and he must know a hole when he sees one. He should be something more besides. A good fireman can be taught certain of these matters.

But looking at the fireroom broadly, it is much like a large laboratory, or a chemical factory. The manager of such an establishment does not expect laborers to determine his mixtures, or to pass upon his product. Technical work calls for technical knowledge and the chemistry of the processes is properly organized. Is it to be expected, then, that men knowing nothing of chemistry should be qualified to manage a fire properly with varying fuel; or that they should be able to judge accurately of gas pressures and gas velocities? I recall a number of stations which have been running for some years, with good equipment, and which have been deficient in draft. The firemen are good men of their sort, but suggest no improvements. In another instance a certain percentage of $CO_2$ was insisted upon with a technical man to collect and analyze samples. The regular fireman managed the fire as he saw fit, provided the $CO_2$ showed a certain percentage. The boiler trials gave an evaporation of about eight pounds where eleven was possible.

Such a trial is of little value. It tells nothing about the coal, and nothing about the furnace. We do not attempt to judge of the worth of a new harness and a new wagon by hitching up an old worn out horse that is good for only half a load anyway. In order to judge a furnace, and a coal, fires must be as perfect as they can be made. If only 60 per cent of the heat in the coal is turned into the steam, little will be learned about the coal or anything else. The assumption that a low series of tests is valuable because it is somewhere near operating conditions is wide of the mark, for operating conditions should not be represented by poor results. When an oil is tested on a bearing, the whole thing is made as clean as possible. We do not throw a handful of dirt in with the oil because we believe that the bearing is dirty in everyday work.

The man who runs boiler trials should first learn the fireman's business. Simply measuring coal and water, air pressure and $CO_2$, and letting a laborer manage the fire, is a poor way of trying out a coal or a furnace.

A class of technical men who will spend a year or two in learning the business of firing is needed in many firerooms; for firing, while dirty work, calls for an educated mind, and such a man could take a small group of boilers with the usual fireroom help and carry perfect fires. There could be a number of such men in any large fireroom, each in his overalls, with goggles in his pocket and the common equipment of boiler-room instruments at hand. His would be the controlling judgment of the fires. He would know when holes were coming and when clinkers were forming. If draft was deficient, he would know why and what move must be made.

Such men are not easily obtainable. I know of but two technical men who have been willing to work at stoking, though no doubt there are many more. And new methods in the fireroom would be necessary, for such men must be given authority and adequate salary. But they would make it possible to avoid a drop of proper efficiency at 80 per cent to an improper one of 60 per cent. Labor costs might increase, perhaps, at first, but the labor cost is only 6 per cent of the fuel cost so that 15 per cent more labor is only 1 per cent of the fuel. With present methods a change of 1 per cent in fuel, particularly tending toward lower efficiency, is never noticed. The ultimate effect would be toward lower labor cost and much lower fuel cost.

# EDITORIAL COMMENT

### A Vicious Example.

STRIKES, like war, are notoriously unprofitable—a manifestation of the eternal falsity and failure of the policy of government by force. They prove nothing but the temporary location of the balance of power. They settle nothing (unless accidentally or incidentally) except the dictates of transient expediency.

Seldom, however, has a strike been so utterly unamiable, from every point of view, as that of the traction company's employees in Philadelphia, which, at the time of writing, is still unsettled. No one of the parties involved—corporation management, labor union, or municipal government—awakens even for the shortest moment one of those invigorating pulses of sympathy that is sometimes aroused in a bystander by evident sincerity of purpose, even when that purpose is misguided and misdirected. Unionism and anti-unionism are both seen at their worst, and the vicious quarrel goes on, in contemptuous disregard of nominal efforts toward law and order by a police force corrupt to the point of utter inefficiency.

The only uplift amid the whole demoralizing spectacle is the effect produced by the State constabulary—an evidence of the power inherent in a little clean honesty and courage when it determines to assert itself.

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### Fallacies in Economics.

HE opponents of protection hate it so cordially for itself alone that any suggestion of secondary ill effects is supererogatory. Nevertheless it is quite possible that much of the economic disturbance in the United States today is collaterally, if not lineally, descended from the "parent of the trusts." The disturbance here referred to is not the physical disturbance, so to speak, of artificially maintained prices and general though unequal inflation of values. It is the mental disturbance unconsciously bred by the conception of legislation as something superior to economics—of statute law as something that can overrule and reverse natural law. The inference is easy. Tariff advocates have always asserted that prosperity in the United States is the direct, necessary, and sole result of protection. If, then, one legislative measure can make one class or part of the nation great and rich, some other bill or law should be equally effective in making another class or section of the people great and rich. Next, by a simple extension of functions, legislation may and must prescribe just how great and rich each class shall be. All legislation tends to become special, conferring, withholding, extending, limiting, or regulating privileges and profits.

The corrupting tendencies of such a state are apparent. But beyond plain vulgar dishonesty, it creates the delusion that by the making of many statutes we shall bring in the millennium—at least, we shall have no difficulty in annulling the laws of economics or changing the constants of nature. When one measure fails to produce the expected result it is amplified by another, until enterprise, industry and traffic are so baffled on every side by artificial barriers that the current wastes its energy in whirls and eddies, grows sluggish, and stops. The country gropes, bewildered, in a maze of railroad and corporation legislation, where the simple necessity has been, and still is, a plain interpretation, energetic prosecution, and vigorous enforcement of common law and equity—or above all, of the penal statutes.

REVIEW OF THE ENGINEERING PRESS.
"THE WORLD IS ITS FIELD"

# ALLOYS OF COPPER, ALUMINIUM AND MANGANESE.

A SUMMARY OF THE NINTH REPORT TO THE ALLOYS RESEARCH COMMITTEE OF THE INSTITUTION OF MECHANICAL ENGINEERS.

*W. Rosenhain and F. C. A. H. Lantsberry—Institution of Mechanical Engineers.*

THE eighth Report to the Alloys Research Committee of the Institution of Mechanical Engineers, an abstract of which was given in THE ENGINEERING MAGAZINE for March, 1907, described an extensive research into the properties of the alloys of copper and aluminium, up to a point "where the way was clear for investigating the influence of a third metal." During the last three years, ternary alloys of copper, aluminium and manganese have been under investigation by W. Rosenhain and F. C. A. H. Lantsberry, and the literature of metallurgy is now enriched by the appearance of the ninth Report to the Alloys Research Committee, which deals exhaustively with the properties of these alloys. We choose from the voluminous data given in the 174 pages of the Report a few results which give at least a general indication of the effect of the addition of manganese on alloys of copper and aluminium, and of the possibilities of practical utility which inhere in the alloys investigated.

Considering first the alloys rich in copper, a series of exploratory tests on twenty-two alloys of copper and aluminium lying within the limits of an aluminium content of 11 per cent. and a manganese content of 10 per cent. resulted in the selection for preparation on a large scale and for more complete investigation of nine alloys, ranging in manganese content from 0.5 per cent. to 5 per cent., and in aluminium content from 7 to 10 per cent. The general inference drawn from the result of the exploratory tests is that the effect of manganese is in most respects similar to that of aluminium itself, but that while larger additions of manganese render the alloy brittle and weak. the first effects of adding small quantities of manganese are to stiffen the alloys, that is, to raise both their yield points and ultimate strengths without diminishing their ductility. Although only three of the nine alloys selected were found sufficiently promising to warrant complete study (including kinetic tests), tensile tests on sand-cast, chill-cast, rolled, and cold-drawn bars gave a series of interesting results, several of the alloys proving themselves decidedly superior to any of the binary alloys of copper and aluminium. For instance, in the case of sand castings, alloy No. 2, containing approximately 10 per cent. of aluminium and 1 per cent. of manganese, showed a yield point of 14 tons per square inch, an ultimate stress of 35.76 tons per square inch, and an elongation of 22.5 per cent. on 2 inches; the best of the binary alloys gave a yield point of 11.3 tons, an ultimate stress of 31.7 tons and 21.7 per cent. elongation on two inches in the form of sand castings. Alloy No. 6 of the present series, containing approximately 9 per cent. of aluminium and 2

per cent. of manganese, gave almost exactly the same yield point and ultimate stress as the 10 per cent. copper-aluminium alloy, but shows 46 per cent. elongation on 2 inches as compared with 36 per cent. In the form of rolled bars, 13/16 inch in diameter, the best of the ternary alloys attain an ultimate stress of nearly 43 tons per square inch, with a yield point of 23 tons and an extension of 22.5 per cent., while another alloy, with a yield point of 19 tons and an ultimate strength of 40.5 tons, shows an elongation of 40 per cent. on 2 inches. The results of these tensile tests lead to the definite conclusion indicated above, that the effect of the addition of manganese in relatively small amount to an alloy of aluminium and copper is to stiffen the alloy.

Notwithstanding the comparatively wide variations of tensile strength which exist between these nine alloys, their hardness numbers were found to differ very slightly; the Brinell number varied from 170 to 199. The torsion tests yielded results generally consistent with those of the tensile tests; alloy No. 9, however, containing approximately 8 per cent. of aluminium and 5 per cent. of manganese, was remarkable in giving both the highest maximum strength in torsion and the largest angle of twist. The ratio of the maximum stresses in torsion and in tension varied from 0.75 to 0.90, but never reached or exceeded unity, as was the case with a number of the binary copper-aluminium alloys. Under the alternating-stress test none of the nine alloys gave as good a result as one of the binary alloys of copper and aluminium, but taking into consideration their much higher tensile strengths, their behavior under this test was remarkably good.

The three alloys chosen for complete study were No. 2, manganese 1 per cent. and aluminium 10 per cent.; No. 3, manganese 2 per cent. and aluminium 10 per cent; and No. 6, manganese 3 per cent. and aluminium 9 per cent. The tests included a determination of the elastic limit and elastic modulus, the autographic stress-strain diagram, the investigation of the effect of cold drawing on the elastic modulus of the alloys, tensile tests at high temperatures (up to 450 degrees C.) a series of dynamic tests, an examination of the effects of heat treatment, and fresh- and sea-water corrosion tests.

The elastic limits for the three alloys in numerical order were found to be approximately 8, 9, and 12 tons per square inch, while the elastic modulus ranged from $13.6\times10^6$ pounds per square inch in No. 2 to $14.9\times10^6$ in No. 6. Cold drawing does not appreciably alter the modulus, although the elastic limit is, of course, very considerably raised. The low values of the elastic moduli as compared with those of steel are important as affecting the possible utility of these alloys in high-speed machinery, etc.

The results obtained in the tensile tests at high temperatures were very similar to those found for the 10 per cent. copper-aluminium alloy: the tensile strength appears to be well maintained up to about 300 degrees C. but then falls off rapidly. There is some reason for believing, however, that on prolonged exposure to moderately high temperatures the ternary alloys would behave better than the pure copper-aluminium alloys.

The dynamic tests included alternating-stress tests by direct reversals of stress, single-blow impact tests on the Izod machine, and repeated bending-impact tests with two different values of blow. Under direct-reversal tests the three alloys behaved practically identically; the results indicate that the safe range of maximum stress is approximately 25 tons per square inch when the rate of reversals approaches 1,000 per minute, about 1 ton less than the figure for the 10 per cent. copper-aluminium alloy. Under the single-blow impact test, on the other hand, the present alloys showed an absorption of from 9.5 to 10.5 foot-pounds for fracture, the figure for the 10 per cent. copper-aluminium alloy being only 4.5; evidently manganese increases the power of copper-aluminium alloys to resist sudden shock. Under the repeated bending-impact test, with a tup weighing 6.15

pounds falling through a height of 2.01 inches, alloy No. 2 fractured only after more than 900 blows, while No. 6 failed under 600. With the lighter tup (4.71 pounds) and lesser fall (1.01 inch) ordinarily used in impact tests on steel, the order of the alloys was changed; all three, however, required over 10,000 blows, while the best result yet obtained with Swedish Bessemer steel under the same conditions is a resistance to 6,000 blows.

The three alloys were found to offer a most remarkable resistance to abrasion. While rings of rail steel lost 64.5 milligrams and a ring of tool steel 27 milligrams, a ring of Alloy No. 6 lost only 10 milligrams and the other two alloys behaved nearly equally well. If the behavior of the alloys in practice should bear out these remarkable results, a field of special usefulness should be open to them, particularly as the alloys machine quite readily. All the alloys exhibited also a marked resistance to corrosion in fresh and sea water. In fresh water the ternary alloys appear to be decidedly less liable to corrosion than the binary alloys of copper and aluminium; in sea water, on the other hand, alloy No. 2 appears to lose nearly as much by corrosion as Naval brass; in alloy No. 6 no corrosion whatever was observed.

Turning now to the alloys rich in aluminium, a preliminary study of the aluminium-manganese series of binary alloys showed that a binary eutectic exists close to the aluminium end of the series, while the alloys on the manganese side of this eutectic contain increasing quantities of the compound $Al_4Mn$, a hard brittle compound which at once limits the possible extent to which manganese can be usefully added to alloys consisting principally of aluminium. The study of tenary alloys was, therefore, confined to the range containing less than 4 per cent. of either copper or manganese. The results of tensile tests on eight alloys in this range, while not very promising in themselves, indicated that two alloys, containing, respectively 2 per cent. copper and 2 per cent. manganese, and 3 per cent. copper and 1 per cent. manganese, were worthy of further study. The investigation of these two alloys was carried out along the same general lines as those followed in studying the alloys rich in copper.

An interesting feature of the results obtained with these alloys is the determination of the very great extent to which the properties of the metal depend, in the case of castings, on the temperature at which the metal is poured into the moulds. Tensile tests of sand castings of the two selected light alloys show that they compare favorably with pure copper-aluminium alloys, and this is still more notable in the case of chill castings. The tensile tests of alloy No. 11 (3 per cent. copper, 1 per cent. manganese) which show an ultimate strength of 12 tons per square inch, with an elongation of 13.5 per cent. on 2 inches, are among the most remarkable results of this investigation of ternary alloys, since they very considerably exceed the results of any of the binary alloys of aluminium with copper. This superiority, however, is not maintained in the case of rolled bars; although the results are slightly better than those found in the binary series, the difference is not nearly so important as in the case of chilled castings. There does not seem to be any advantage in using the ternary alloys as compared with the alloys of aluminium with copper alone. It was found also that the two light alloys could not be drawn cold to any considerable extent without drawing hollow, even the amount of cold working attempted in the case of alloy No. 11 in the process of "drawing and annealing" producing hollowness. Alloy No. 10, however, containing 2 per cent. of each added metal, stood the process of drawing with annealing in a satisfactory manner. The specific gravities of the two alloys range from 2.71 to 2.80 for No. 10, and from 2.67 to 2.79 for No. 11. In all cases the rolled material was markedly denser than the chill cast.

The elastic limit is 7.15 tons for both alloys, and the elastic moduli are $10.75 \times 10^6$ and $10.4 \times 10^6$ respectively. The alternating stress tests indicate that

the safe range for alternating stresses is for alloy No. 10, 9.4 tons per square inch, and for alloy No. 11, 8.8 tons per square inch. Under the single-blow impact tests the two alloys absorbed 4.1 and 5.5 foot-pounds at fracture, surprisingly high results in view of the relatively low tensile strength of the materials. Under the repeated bending-impact test as applied to the heavy alloys or to steel specimens, these light alloys would have fractured after very few blows; a lower height of drop was accordingly employed (0.71 inch instead of 1.01 inch) and with a tup weighing 4.71 pounds the alloys fractured after 590 and 672 blows respectively.

Special experiments were made on both heavy and light alloys to determine whether the alloys could be prepared from manganese derived from a commercial 80 per cent. ferro-manganese. In the case of the heavy alloys, the results showed that if a cupro-ferro-manganese is first prepared and the alloy made from this the results are satisfactory, but that it is not possible to use ferro-manganese directly for the preparation of the copper-rich alloys. In the tests on alloys rich in aluminium, an alloy of the type of No. 10, prepared by the use of ferro-manganese direct and containing 0.52 per cent. of iron, gave results appreciably better than those obtained from the original No. 10. It is probable that the introduction of small proportions of iron may materially improve these light alloys.

## GRAPHITE AS A LUBRICANT.

ADVANTAGES OF USING DEFLOCCULATED GRAPHITE WITH OTHER LUBRICANTS.

*Charles M. Mabery—American Society of Mechanical Engineers.*

IT has been claimed that in the case of considerably more than half of the 10,000,000 horse power in use in Great Britain, 40 to 80 per cent. of the fuel is spent in overcoming friction and that a considerable proportion of this power is wasted by imperfect or faulty lubrication. In the United States the condition is often worse, and losses of 50 per cent. or greater are found in factories by lubrication experts where the annual expense for lubrication amounts to thousands of dollars. Imperfect and inefficient lubrication was the rule in the days before the use of products from petroleum, and it was not until the discovery that the heavy hydrocarbons in petroleum possessed the qualities requisite for lubrication—viscosity, durability and stability—that a new era in lubrication was begun. In fact, modern high speeds and excessively heavy loads early demanded better lubrication, and this was first met by the use of the heavier hydrocarbons. Otherwise the earlier methods have undergone but little fundamental change and indeed for lighter work good oils composed for the most part of the hydrocarbons $C_n H_{2n}$ and $C_n H_{2n-2}$ have been obtained from the crude oils of the Pennsylvania type containing a considerable proportion of the hydrocarbons $C_n H_{2n+2}$. These compound oils were used, petroleum products being mixed with vegetable oils and various animal oils and greases, and also heavier lubricants obtained from Texas and California petroleum. The superiority of an ideal solid lubricant, that is, one that should embody an equivalent of the desirable qualities of the liquid products with a greatly superior wearing quality and a low coefficient of friction and at the same time a substance readily convertible into a form that can be conveniently applied to the various forms of journals and bearings, has always been recognized.

According to Professor Mabery, who reported the results of extended experiments at a recent meeting of the American Society of Mechanical Engineers, soapstone asbestos, natural graphite, etc., do not altogether possess these fundamental qualities of the liquid products. Greases compounded with graphite are useful on low-speed bearings and under heavy work. Natural graphite serves an excellent purpose on cast-iron bearings, acting as a surface evener of the porous

metal. On finer surfaces care is necessary that it does not collect in such quantities as seriously to scratch or abrade the journal and bearing.

Of all the solid bodies available for lubrication, graphite possesses the desirable unctuous quality and great durability, and when in its purest condition and in a state of extreme subdivision it is a most useful lubricant. As made by the Acheson process two forms of commercial graphite for this purpose are produced, the unctuous and the deflocculated modifications. The first is leafy in structure, coherent, and extremely unctuous or greasy to the touch; it is segregated and not highly disintegrated. The second is also unctuous in a high degree, but very pulverulent and capable of extreme subdivision; it is readily converted into a deflocculated condition. This form in water forms the commercial "Aquedag" or aqueous Acheson deflocculated graphite. In combination with oils it is known as "Oildag." The small quantity of graphite distributed by water between a journal and bearing while sustaining a load of 70 pounds per square inch is really remarkable especially when it is considered that under high speed conditions it maintains an extremely low coefficent of friction.

All proper lubrication necessarily presupposes proper bearings and this involves their care and maintenance. A lubricant is merely an unctuous body that readily forms a continuous, coherent, durable film capable of holding apart rolling or sliding surfaces, and itself interposing the least possible resistance. The economic problem in lubrication depends upon the use of such a lubricant under suitable conditions. Water in itself possesses no oiliness whatever, but in certain circumstances in cylinders it is found to assist in imparting to the metallic surfaces an extremely smooth condition, which serves materially to reduce the friction.

The distillation and refining of oils has much to do with the final product and the elimination of acid products by the use of caustic soda without producing such an excess as will produce an emulsion is one of the problems of the refinery. The ordinary tests of lubricating oil include the determination of the viscosity, specific gravity, flash and fire temperatures, while an essential not so readily determinable is that of oiliness or greasiness. In addition there are mechanical tests where the effects of speed, load, temperature, and the frictional effects due to viscosity and oiliness are studied.

Professor Mabery's studies were undertaken with the Carpenter machine and involved not only the ordinary use of lubricants but those with which graphite was mixed and also water, kerosene, and fuel oil containing graphite, the amount added in each case being 0.35 per cent. From his experiments, Professor Mabery reached the conclusion that in the deflocculated form graphite could be used as a solid lubricant with great economic efficiency in all forms of mechanical work. "One of its most characteristic effects is that of a surface-evener, by forming a veneer, equalizing the metallic depressions and projections on the surfaces of journal and bearing; and being endowed with a certain freedom of motion under pressure, it affords the most perfect lubrication. In automobile lubrication the great efficiency of graphite, in increasing engine power, in controlling temperatures, and in decreasing wear and tear on bearings, has been brought out in a series of tests conducted by the Automobile Club of America. In connection with the reduction in friction of lubricating oils by graphite the extremely small proportion necessary is worthy of note; the proportion used in this work is equivalent to one cubic inch of graphite in three gallons of oil. The curve of temperature for Aquadag, which shows an increase but slightly above that of the surrounding atmosphere, demonstrates an important economic quality of controlling temperatures in factory lubrication, thereby avoiding the danger of highly heated bearings which are frequently the cause of fires." The advantage of graphite was also most striking in the tests where graphite was used with water, the latter serving merely as a vehicle and being devoid of lubricating property.

# THE TRAINING OF MEN.

PRACTICAL TRAINING COMBINED WITH EDUCATIONAL WORK AS DEVELOPED AT THE WEST LYNN WORKS OF THE GENERAL ELECTRIC COMPANY.

*M. W. Alexander—American Society of Mechanical Engineers.*

THE comprehensive apprenticeship system developed at the Lynn works of the General Electric Company is described in a paper by Mr. Magnus W. Alexander, read recently before the American Society of Mechanical Engineers, and published in the *Journal* for January. It will be recalled that in 1906, after the appentice system had been for several years in successful operation at the Lynn Works, Mr. Alexander discussed it most fully in a paper which was abstracted in THE ENGINEERING MAGAZINE for January, 1907. Since that time the educational system, which aimed at training as trade apprentices boys of grammar school education has been extended, so that in addition provision has been made for training machine specialists from the ranks of the workmen, foremen, designers, superintendents from the highly skilled and more intelligent mechanics, draftsmen, testers, erectors, and business workers from high-school graduates, and finally for providing suitable advanced work for the university graduate so as to train him for a position of maximum usefulness.

The regular apprentice training has been maintained essentially along the lines outlined by Mr. Alexander in his previous paper, but the work has been developed and extended wherever possible. Boys of at least 15 years of age are taken for a four years course to fit them to become tool and die makers, instrument makers, and pattern makers, and boys slightly older for a three years course to become iron, steel and brass molders, blacksmith and steamfitter apprentices. During this time they receive regular and liberal compensation and are given special daily instruction in the class room as well as in the training rooms and shops, the instruction being under a special superintendent.

"The training room is a special department for apprentices, a trade school in the factory, with this distinction, however, that all work is commercial work selected solely for its instructive character. It had its inception in the belief that the apprentice should receive his initial training under the most favorable conditions and expert supervision. The very fact of this work being part of the commercial output of the factory automatically insures a high standard of quality and quantity, and eliminates the false notions of these values usually found in purely educational trade schools. As a matter of record the work of the apprentice is of a very high standard. Moreover on work of a repetitive character, the apprentices attain a speed of from two-thirds to three-quarters of that of the average workman, and a quality of work fully equal to the average. On work generally classed as 'tool work,' the apprentices very closely approach and sometimes even equal the work of the skilled journeyman."

"Training rooms have been established for tool-maker and pattern maker apprentices, occupying departments of about 15,000 square feet, and 4,000 square feet, respectively. No training room has yet been organized for molder apprentices, as there are only a few of them and as this part of the system is not yet very far developed. The training rooms are in charge of expert mechanics who act as assistant foremen to the superintendent of apprentices." Few of these expert mechanics are required, as the apprentices themselves act as instructors to those less advanced, and this is not only valuable for its economy but for its educational value in developing the apprentices themselves. Good apprentice wages are paid by the company and a high standard of work is maintained so that a large number never pass beyond the initial probationary period, while throughout their course they are carefully watched. At times apprentices are

loaned to the factory for a few days or weeks and at the conclusion of the course they are ready for steady employment at good wages.

There are over 200 trade apprentices at the Lynn Works and 101 have already graduated, of whom 63 are in the employ of the company, 8 serving as assistant foremen, 5 as inspectors, and 12 as tool draftsmen, while the remainder are skilled journeymen. The point is made clear to all apprentices, however, that a position as foreman or superintendent should not be the sole aim except for those with predominant ability.

Training for positions as draftsmen and designers is limited to young men with a complete high-school education who pass examinations in algebra, plane geometry and elementary physics. Before being indentured as draftsmen apprentices the candidates must serve a trial period of two months. The period is three years and the compensation is 10 and 12 cents per hour respectively for the first and second six month periods, 15 cents for the second year, and 20 cents for the third year. They receive then a cash bonus of $75 and a Certificate of Apprenticeship which states their efficiency in practical and theoretical work. They receive instruction of college rank daily except on Saturday and during part of the summer, the subjects covered being advanced algebra, descriptive and analytic geometry, plane trigonometry, advanced physics, inorganic chemistry, strength of materials and machine design. The closest correlation is maintained between the theoretical and practical and examinations are held three times a year at which a mark of 70 per cent is required.

Draftsman apprentices receive machine-shop training during the first year and a half and drafting instruction during the remainder of the three years' course. The machine-shop work is given principally in the apprentice training room and part of the time is devoted to repair work on machinery and to tool work in order to instill into the mind of the future draftsman the possibilities and limitations of the shop as well as methods for most economical manufacture. The drawing office instruction is of a high standard and one object of the present course was to improve the standards of draftsmanship which had deteriorated in recent years. Accordingly it was decided to demand an entrance examination of a candidate before his commencing the course, and then to develop not only competent tool and mechanical draftsmen but high-grade intelligent designers.

The most recent provision for systematic training at the Lynn works has been the establishment of courses open to high-school graduates in which young men are prepared to become testers and erectors of machinery and are fitted for business careers in a manufacturing establishment.

"Tester apprentices must pass an examination the same as draftsman apprentices, and the length of the two courses and the rates of compensation are identical. The practical work consists of about six months of testing motors or transformers, followed by about nine months of assembling and winding the remaining year and nine months being devoted to a training in the various testing departments for meters and instrument, arc lamps, rectifiers, railway motors, and special electrical machinery, also turbines and turbo-generators."

"Business apprentices are recruited from high-school graduates who have a leaning towards business activity, but not sufficiently high scholarship to pass the entrance examination and continue the educational work prescribed for the drafting and testing courses. These apprentices enter upon a two years' course at a compensation of 12 cents per hour for the first year and 15 cents for the second year, with a cash bonus of $50 at the successful termination of the course. They begin with six months of general stockkeeping, which acquaints them with the principal materials used in the factory, and leads to an appreciation of the value of these materials. Then follows a nine months' training on the writing of material lists and the compiling of stock reports. In this way the apprentices learn to read drawings

and to make up lists of the kinds and amounts of materials required for the production of one or several machines or machine parts delineated on drawings. They learn furthermore, to calculate the losses that result from the cutting off of bars and the punching of various shaped parts. All this leads to accuracy and develops an interest in the value of stock which will show in the stockroom work of a more independent character which occupies most of the remaining nine months. These apprentices will also be given a training in shop clerical work, and this will be supplemented by instruction in arithmetic and geometry, the reading of drawings, and simple bookkeeping."

The General Electric Company established many years ago, a "student course" for young men of collegiate engineering training providing for a two years' experience in the various testing departments. In its present form the student course is divided into "engineering" and "commercial" courses. Admittance to either is dependent upon a complete engineering-college education, and almost invariably applicants are required to appear before a committee. The courses last two years and the compensation has been set at 20 cents per hour ($11 per week) for the first year, 22½ cents per hour ($12.37 per week) and 25 cents per hour ($13.75 per week) respectively for the two halves of the second year. Without written agreement it is mutually understood that the student will give to the company two years of faithful service, and that the company on the other hand reserves the right to terminate the work of any student who at any time proves that he is not above the average either in capacity and special fitness or in good intentions. There are weekly evening lectures which all students are expected to attend, when the engineers and foremen of the company as well as the heads of the business departments informally address the young men and stimulate a frank and free discussion of the subject under consideration. These lectures cover the principal materials of construction, important manufacturing processes, and the various lines of apparatus manufactured by the company, and put the student in the possession of up-to-date practical information which they would not be able to get from books or other outside sources. Lectures are also given on business methods. Commercial students throughout their course work in the shops and testing rooms on construction, assembling, repairs and tests, and spend about two months on meter and instrument testing, two and a half months on arc lamp testing and repairing, one and a half months on transformer winding and assembling, four months on transformer and rectifier testing, two and a half months on stationary and railway motor winding and assembling, six months on stationary and railway motor testing, and five and a half months on turbine testing or in other special assignments. They are stimulated to keep in touch with the latest engineering developments by reading the technical magazines and are shown the value of following up the advertisements in them as one means of getting acquainted with the general features of apparatus manufactured by competitors, while they are encouraged to observe such machinery and instruments under actual use.

The engineering students receive most of their training in the machine shops, winding department and drawing office, while the latter part of the course is devoted to testing, or to production cost or other business activities as the individual student may make advisable. The first work usually is in the apprentice training room and then a period in various departments of the factory follows when they are required to study problems of production. The next division of the student's time is spent in the drafting office working on detail drawings, assembly and lay-out work and problems of design, especially with a view to economic wholesale manufacture. The final period of the course is spent in specific work along lines leading to some definite occupation after graduating from the course in which the student's aptitude or proficiency has indicated his field of greatest usefulness.

# THE COST OF MILL BUILDINGS.

DIAGRAMS AND TABLES GIVING APPROXIMATE COSTS PER SQUARE FOOT OF TOTAL FLOOR AREA OF BRICK AND FRAME MILL BUILDINGS.

*Charles T. Main—Engineering News.*

THE paper from which the diagrams and tables on the following pages are taken was originally presented by Charles T. Main before the New England Cotton Manufacturers' Association about six years ago. Revised to conform with prices prevailing about January, 1910, it is reprinted in *Engineering News* for January 27. The diagrams show the approximate cost per square foot of total floor area of brick mill buildings of various dimensions and from one to six stories in height. The costs used in making up the diagrams are based largely upon the actual cost of work done under average conditions of cost of materials and labor, and with average soil for foundations. In the tables are given factors by which the cost of frame structures may be calculated from the cost of buildings of the "slow-burning type" as given in the diagrams.

The diagrams can be used to determine the probable approximate cost of proposed brick buildings, of the type known as "slow-burning," to be used for manufacturing purposes. The curves, which were derived primarily to show the estimated cost per square foot of gross floor area of brick buildings for textile mills with a total floor load of about 75 pounds per square foot, include the cost of ordinary foundations and plumbing, but no allowance is made for heating, sprinkler or lighting systems; these items would add roughly 10 cents per square foot of floor area. The costs given, of course, refer only to average conditions; they may require modification to meet extraordinary conditions, among which may be mentioned the following:

(*a*) If the soil is poor or the conditions of the site are such as to require more than the ordinary amount of foundations, the cost will be increased.

(*b*) If the end or a side of the building is formed by another building, the cost of one or the other will be reduced slightly.

(*c*) If the building is to be used for ordinary storage purposes with low stories and no top floors, the cost will be decreased by from 10 per cent for large low buildings to 25 per cent for small high structures, about 20 per cent usually being a fair allowance.

(*d*) If the buildings are to be used for manufacturing purposes and are to be substantially of wood, the cost will be decreased by from 6 per cent for large, one-story buildings, to 33 per cent for small, high buildings; 15 per cent would usually be a fair allowance.

(*e*) If the buildings are to be used for storage, with low stories and built substantially of wood, the cost will be decreased by from 13 per cent for large, one-story buildings to 50 per cent for small, high buildings; 30 per cent would usually be a fair allowance.

TABLE I. RATIO OF COST OF VARIOUS BUILDINGS TO THAT OF BRICK MILLS, STANDARD CONSTRUCTION.

| Superficial feet of Floor in one story. | Frame Mills. | | | | | | Brick Store House. | | | | | | Frame Store House. | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 Sto. | 2 Sto. | 3 Sto. | 4 Sto. | 5 Sto. | 6 Sto. | 1 Sto. | 2 Sto. | 3 Sto. | 4 Sto. | 5 Sto. | 6 Sto. | 1 Sto. | 2 Sto. | 3 Sto. | 4 Sto. | 5 Sto. | 6 Sto. |
| 1,250 | .86 | .67 | | | | | .80 | .73 | | | | | .70 | .51 | | | | |
| 2,500 | .86 | .73 | | | | | .85 | .73 | | | | | .75 | .58 | | | | |
| 5,000 | .89 | .78 | .75 | .73 | .70 | .67 | .83 | .80 | .78 | .76 | .76 | .75 | .74 | .60 | .56 | .53 | .51 | .48 |
| 7,500 | .90 | .79 | .77 | .74 | .71 | .69 | .85 | .81 | .78 | .77 | .76 | .76 | .77 | .63 | .58 | .55 | .53 | .51 |
| 10,000 | .90 | .80 | .78 | .75 | .73 | .70 | .87 | .81 | .79 | .78 | .77 | .76 | .78 | .65 | .60 | .57 | .55 | .53 |
| 15,000 | .91 | .82 | .79 | .77 | .75 | .72 | .89 | .83 | .81 | .79 | .78 | .78 | .81 | .67 | .64 | .61 | .59 | .56 |
| 20,000 | .92 | .83 | .81 | .79 | .77 | .74 | .90 | .84 | .82 | .80 | .80 | .79 | .82 | .70 | .67 | .64 | .61 | .59 |
| 25,000 | .92 | .85 | .82 | .80 | .78 | .76 | .91 | .85 | .83 | .82 | .81 | .80 | .83 | .72 | .69 | .66 | .63 | .61 |
| 30,000 | .93 | .86 | .84 | .81 | .80 | .77 | .91 | .86 | .84 | .82 | .81 | .81 | .84 | .73 | .70 | .67 | .65 | .62 |
| 35,000 | .93 | .87 | .84 | .82 | .80 | .78 | .92 | .86 | .84 | .83 | .82 | .81 | .85 | .74 | .71 | .68 | .66 | .63 |
| 40,000 | .93 | .87 | .85 | .83 | .81 | .79 | .92 | .87 | .85 | .84 | .83 | .82 | .86 | .75 | .72 | .69 | .67 | .64 |
| 45,000 | .94 | .87 | .85 | .83 | .82 | .79 | .92 | .87 | .85 | .84 | .83 | .82 | .86 | .76 | .72 | .70 | .67 | .65 |
| 50,000 | .94 | .88 | .86 | .84 | .82 | .80 | .92 | .88 | .86 | .84 | .83 | .83 | .87 | .77 | .73 | .71 | .69 | .66 |

(*f*) If the total floor loads are more than 75 pounds per square inch the cost is increased.

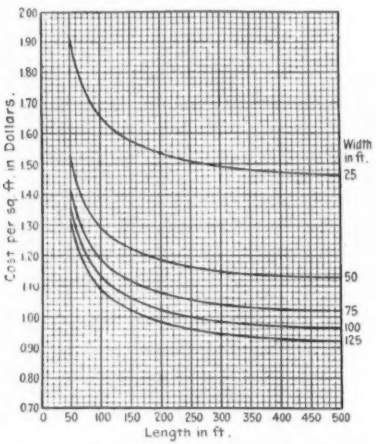



FIG. 1. COST OF ONE-STORY BRICK BUILDINGS.

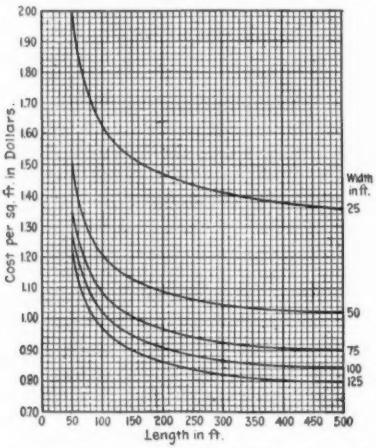



FIG. 2. COST OF TWO-STORY BRICK BUILDINGS.

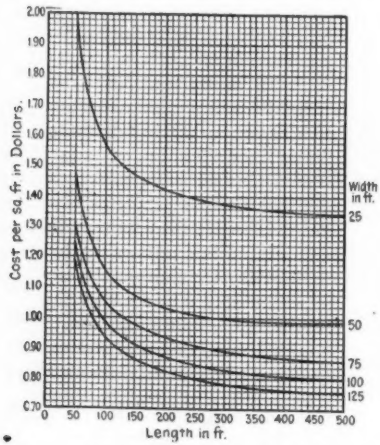



FIG. 3. COST OF THREE-STORY BRICK BUILDINGS.

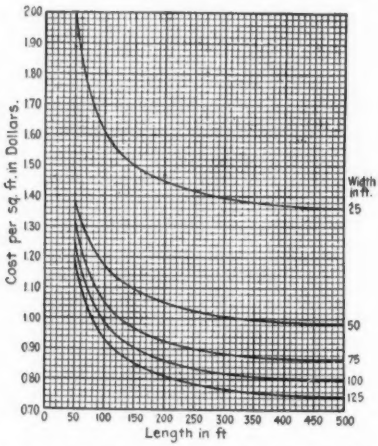



FIG. 4. COST OF FOUR-STORY BRICK BUILDINGS.

(*g*) For office buildings, the cost must be increased to cover architectural features in the exterior and interior finish.

The cost of very light wooden structures is much less than the above figures would give. Table I shows the approximate ratios of the costs of frame mills, brick store houses and frame store houses to the cost of standard mill construction as shown in the curves.

The costs which form the basis of the estimates are shown in Table II. The cost of brick walls is based on 22 bricks per cubic foot, costing $18 per thousand laid. Openings are estimated at 40 cents per square foot, including windows, doors, and sills. Ordinary mill floors, including timbers, planking and top floor with Southern pine timber at $40 per thousand feet, board measure, and spruce planking at $30 per thousand feet, cost about 32 cents per square foot; this has been used as a unit price. The cost of ordinary mill roofs covered with tar

and gravel, with timber at the prices given above, has been taken as 25 cents per square foot.

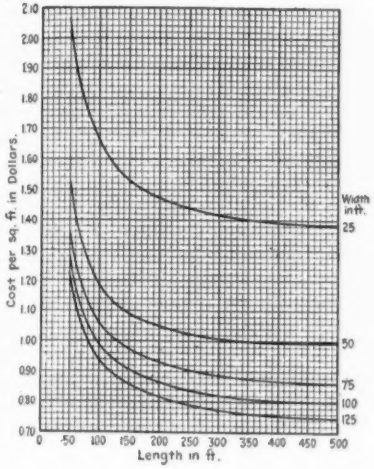



FIG. 5. COST OF FIVE-STORY BRICK BUILDINGS.

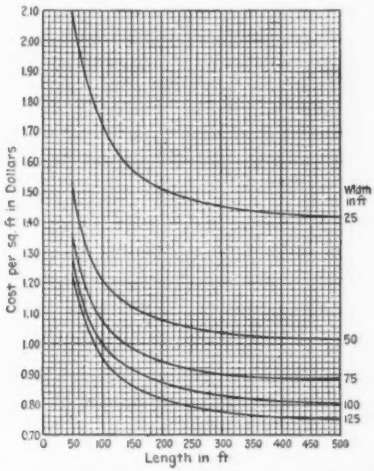



FIG. 6. COST OF SIX-STORY BRICK BUILDINGS.

An examination of the diagrams reveals several interesting facts. Perhaps the most apparent is the decrease in cost as the width of buildings is increased. This decrease is due to the fact that the cost of the walls and outside foundations which is an important item relative to the total cost, is decreased as the width increases. Further, it is apparent that the minimum cost per square foot is reached with a four-story building; a one-story building is the most expensive. The cost of the roof is the same no matter what the number of stories, and the costs of foundations and columns do not increase in proportion to the number of stories; the cost of the walls, however, increases in a greater proportion than the number of stories; in the four-story building the saving per square foot in the cost of foundations and columns with increased height, and the increased cost of walls with increased height are balanced. The diagrams and tables show that the saving in the use of frame construction instead of brick is not so great as is popularly supposed. The only saving is in the cost of the somewhat lighter foundations and of the outside walls. The floors, columns and roof must be of the same strength and type of construction in any case.

The height of stories assumed in making the calculations for the curves are as follows: from ground to first floor, 3 feet; height of stories for buildings 25 feet wide, 13 feet; for buildings 50 feet wide, 14 feet; for buildings 75 feet wide, 15 feet; and for buildings 100 and 125 feet wide, 16 feet. The cost of stairways, including partitions, is assumed at $100 each flight. Two stairways and one elevator well are allowed for buildings up to 150 feet long, two stairways

TABLE II. DATA FOR ESTIMATING COST OF BUILDINGS.

| | Foundations, Including Excavations. Cost per linear foot. | | Brick Walls, Cost per square foot of surface. | | Columns, Including Piers and Castings. |
|---|---|---|---|---|---|
| | For Outside Walls. | For Inside Walls. | Outside Walls. | Inside Walls. | Cost of One. |
| One Story Building | $2.00 | $1.75 | $0.40 | $0.40 | $15.00 |
| Two Story Building | 2.90 | 2.25 | .44 | .40 | 15.00 |
| Three Story Building | 3.80 | 2.80 | .47 | .40 | 15.00 |
| Four Story Building | 4.70 | 3.40 | .50 | .43 | 15.00 |
| Five Story Building | 5.60 | 3.90 | .53 | .45 | 15.00 |
| Six Story Building | 6.50 | 4.50 | .57 | .47 | 15.00 |

and two elevator wells for buildings up to 300 feet long, and in buildings over two stories high, three stairways and three elevator wells for buildings over 300 feet long. In buildings over two stories high, $75 is allowed for each plumbing fixture, including piping and partitions. Two fixtures are allowed for each floor having up to 5,000 square feet of floor space, and one fixture additional for each additional 5,000 square feet or fraction thereof.

The cost of reinforced-concrete buildings designed to carry floor loads of 100 pounds per square foot or less, Mr. Main concludes, would be about 25 per cent more than the slow-burning type of mill construction.

## ELECTRIC LIGHTING FOR INDUSTRIAL PLANTS.

A DISCUSSION OF SYSTEMS OF ELECTRIC LIGHTING AS APPLIED TO THE ILLUMINATION OF SHOPS AND FACTORIES.

*George H. Stickney—American Institute of Electrical Engineers.*

IN concluding a review of modern light sources and methods of industrial illumination in THE ENGINEERING MAGAZINE for July, 1909, H. Thurston Owens took occasion to remark that the economic importance in industrial illumination of the high-efficiency light sources which have been developed during recent years lies not so much in the possibilities of reducing lighting bills offered by their substitution for the older forms, as in the increase in the efficiency of workmen which follows any improvement in hygienic conditions. The same view is expressed by George H. Stickney, in a paper on electric lighting for industrial plants read at a recent joint meeting of the American Institute of Electrical Engineers and the American Society of Mechanical Engineers, which is published in the *Proceedings* of the former for February.

The illumination of industrial plants, he says, should be planned principally with reference to the needs of the workman. Satisfactory lighting can increase his efficiency by making him at ease with his surroundings; insufficient illumination can make him dissatisfied. The test of satisfactory illumination is the ability of the workman to do his work quickly and well without excessive eye strain. It is seldom practicable to provide illumination equalling daylight in intensity, and usually the less attention called to the artificial illumination the better. A serious objection to placing a small portable light under the control of the workman is that he not only wastes time in experimenting with it, but frequently places it in such a position that it produces a glare in his own eyes or in the eyes of his fellow workmen. A direct glare soon produces eye strain and the workman demands more light, which only makes matters worse at the cost of increased current consumption. A substantial reduction in current consumption can often be obtained in plants using portable lights by the substitution of general illumination, and at the same time a light much better suited to the needs of the workman can be provided. Such a change is usually resisted at first by the workman whose strained eyes seem to require a greater intensity of light for clear vision, but if the change is made diplomatically the results are usually eminently satisfactory.

While the lighting system in any building or room should be designed to fit the existing conditions, the building should itself be made to conform as far as possible with the requirements of good lighting. Interior finish has a considerable effect on the efficiency of illumination; whitening of the walls, pillars and ceilings will produce a remarkable increase in the effectiveness of the light. In a high-studded room the current consumption for lighting may be higher than in a room with lower ceilings, but a high room permits the use of larger light units with wider spacing, an advantage when the cost of installation and maintenance is considered. It is common practice to space lamps

one and one-half to two times as far apart as their height above the work. Especially in large rooms the use of low, glaring lights should be carefully avoided; the higher the lamps are hung, the less necessary are precautions for avoiding glare. The large window areas of modern factory buildings increase the effectiveness of daylight illuminaton but necessitate a higher intensity of artificial illumination, partly because workmen accustomed to strong day illumination require relatively intense artificial light, partly because of the loss of artificial light through the windows. Where the conditions permit, much light can be retained in the room by reflection by the use of white curtains. In general, processes requiring most light are located near windows and it is well in arranging lamps in a room to favor those parts which have the best daylight.

A room may be lighted by either one of two methods, by local illumination, in which a small lighting unit is placed at each point where particular illumination is required, the other parts of the room depending on low general illumination, or by general illumination, involving the use of relatively large units systematically arranged so that all parts of the room receive approximately the same amount of illumination. General illumination has the advantage that the lighting system, being independent of the detail arrangement of machinery, does not require change with re-arrangement of the work; it does away with temporary construction and the unsightly drop cords, the use of which involves high depreciation and, in many cases, fire risk. General illumination gives a softer and better diffused light, and permits the use of the most efficient illuminants with least wiring and maintenance expense. The choice between general and local illumination, however, is governed to a certain degree by the process to be illuminated. Where, for instance, work is concentrated, general illumination can be used economically; where only a few widely separated points require light, local illumination will be the cheaper.

"In machine shops general illumination can usually be used to good advantage, although some special operations require local lighting. Such local lighting is sometimes provided by loaning extension lamps to the workmen on check, after the practice followed with tools. This practice is often used for automatic machinery, where special light is required for setting up, though a low general illumination is suitable for regular operation. Ordinary machine-shop work requires about 3 foot-candles, though for rough work 1 foot-candle is often satisfactory, while for fine work 6 or more foot-candles may be required. The presence of many overhead belts makes the elimination of shadows with general illumination more difficult, and also is apt to be destructive to drop lights. Modern shops use as few overhead belts as practicable.

"In drafting rooms at least 6 foot-candles should be provided on the drawing board. The selection between general and local illumination depends upon the arrangement of the room and other conditions. Where local lighting is used lamps should be shaded to cut off glare, and if possible located out of the draftsman's reach over the table a little to his left."

The circuits for feeding factory lighting are usually determined by the central-station current available or the requirements of the electric motors in the plant. Either alternating or direct current can be used to equally good advantage; arc lamps, however, do not give a steady light on 25-cycle circuits. The most satisfactory voltage is between 100 to 125, as the most efficient lamps are most readily applied to these voltages. The 220-volt three-wire circuit is commonly used to good advantage. Where motor service is intermittent, affecting the voltage regulation of a local circuit, it is desirable to separate the lighting and power circuits as far as possible. Series circuits should be avoided except when they can be safeguarded. Careful study is usually warranted in dividing up circuits and locating switches to accommodate the requirements of particular processes.

Of the lamps available for industrial illumination, none is suitable for all conditions of lighting. It is often desirable to use several types in different parts of the same plant. Of the principal types of incandescent lamp, the carbon, glower, tantalum and tungsten, the first is economical only when power is very low in cost or in small portable units. As it will stand rougher handling than any of the other forms, the carbon lamp is commonly used with extension cords. Tantalum lamps are finding a considerable use in manufacturing plants, especially where direct current is available, and the tungsten lamp is being extensively adopted for industrial lighting. The latter is by far the most efficient of the incandescent lamps, and where the lamps are protected from excessive vibration or shock, the tungsten lamp gives an exceedingly long burning life. The choice between tantalum and tungsten lamps depends usually on the cost of current and the size of the unit desired. Tungsten lamps are used singly or in groups with metal diffusers or prism glass reflectors, and where there is considerable building vibration, they are provided with spring suspensions.

The types of arc lamps available for industrial illumination include the enclosed carbon, intensified carbon, mercury, luminous magnetites, and flame carbon. Enclosed carbon arcs, both direct and alternating current, are efficient in large units and have a very low maintenance cost. For the higher grades of lighting they are often equipped with diffusers to soften the light and direct it downward at the proper angle. The intensified enclosed arc, which is now available for direct-current multiple circuits, is more efficient than the corresponding capacity of enclosed arc. The flaming arc is now being used to a considerable extent for the lighting of foundries and machine shops where the rooms are high and it is desirable to hang lamps above the crane. The characteristic distribution of the flaming arc, which throws the maximum of light directly downward, particularly adapts it to the lighting of high buildings. Its high power suits it for lighting large areas when hung at a considerable height.

"The remarkable developments of the last few years and the remoteness of ideal efficiency give promise of further development and improvement in illuminants. The importance of these developments in cheapening and at the same time improving the artificial illumination of industrial processes behooves the manufacturer to keep abreast of the times. It should be borne in mind that the first cost of almost every type of electric lamp is relatively small, as compared with the cost of a year's operation, so that the user can afford to take advantage of the developments, even to the extent of throwing out his old lamps and putting in new ones at reasonable intervals."

## THE ELECTRICAL DISTILLATION OF TURPENTINE.

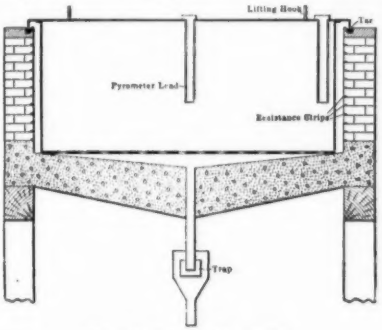
DATA OF A SUCCESSFUL PROCESS FOR THE EXTRACTION OF BY-PRODUCTS FROM WOOD WASTES.

*O. Higman, Jr.—Electrical World.*

THE heating effect of the electric current is utilized for a novel purpose in a plant in Vancouver, B. C., in which the distillation of turpentine and other by-products from sawmill wastes is carried out in electrically heated retorts. So far the process has been worked on a comparatively limited scale. The existing plant has a capacity of only two cords of wood wastes per day. It is soon to be superseded, however, by an installation capable of treating 40 cords of wastes per day, according to O. Higman, Jr., who gives a few data of the process in *Electrical World* for February 17.

The plant at Vancouver, which has a capacity of two cords of wood per day, comprises four retorts, with auxiliary condensers and settling tanks. The con-

struction of the retorts is shown in the accompanying diagram. They are heated by a 110-volt current flowing through resistence strips of iron which encompass each retort in the form of a rectangular spiral, adjacent coils being separated by a course of bricks. The retorts are located directly over a storage room so arranged that the resin and pitch drain from the retorts to the barrels in which they are to be shipped.




CROSS-SECTION OF RETORT.

The wood to be treated is charged into iron boxes, 9 feet by 4 feet by 1 foot 2 inches, which are wheeled into the retort room and are placed in the electrically heated brick settings by a travelling crane. The current consumption for each retort ranges from 350 to 400 amperes. Perforations in the bottom of the receptacles allow the pitch and resin to drain off. A bent flange at the top fitting into a groove filled with pitch on the setting forms an effective seal to prevent the escape of vapors or the entrance of air. Each receptacle is equipped with two sets of leads connecting with direct-reading pyrometers, one of which registers the temperature at the outside, and the other the temperature at the center, of the charge.

"Vapors pass from the retort to a jet condenser consisting of an upright copper pipe down which a spray of water is directed, condensing the turpentine and tar oil from the other gases which are allowed to escape. This mixture of water and turpentine or tar oil is collected below the condensers in settling tanks from which water and turpentine, or tar oil, as the case may be, is separately drawn off by means of stop cocks arranged at suitable levels. The temperature of the brickwork when a freshly charged receptacle is introduced is about 250 degrees C. This temperature is maintained electrically for about two hours. During this time the temperature at the center of the charge has risen to 45 degrees C., while the temperature at the outside of the charge has risen to 130 degrees C., the temperature at which turpentine begins to vaporize. The current is now shut off, and heat passes from the brickwork to the charge for a further period of two hours, when the temperature at the outside of the receptacle has risen to 150 degrees C. and that at the center to 205 degrees C. At this stage practically all (90 to 95 per cent) of the turpentine has been removed." The higher temperature at the center than at the outside of the charge is due to the liberation of latent heat from the hydrocarbons undergoing decomposition.

While the turpentine is evaporating, the resin in the wood melts and is drained off through a trap at the bottom of the retort. When the evaporation of the turpentine is completed, the receptacle is removed to another setting where the temperature of the charge continues to rise without further application of electricity. The receptacle is here connected to another condenser by means of a separate pipe, in order to extact the tar oil without fouling the turpentine system. During this part of the run the temperature at the center of the charge rises to 375 degrees C., at which point the tar oil and pitch, or wood tar, are all extracted and nothing but charcoal remains in the receptacle. The receptacle is placed on a sand floor, the sand sealing the perforations and preventing combustion of the charcoal, and the charcoal is allowed to cool for about three hours, after which it is sacked for shipment. The charcoal product is of an exceptionally fine grade, and contains only 0.25 per cent of ash. The turpentine is rated as equal to the best Southern spirits of turpentine.

The amount and kind of the products obtained depend, of course, on the nature of the wood treated. The following table

gives the quantities of the various products obtained in the treatment of 40,000 pounds of British Columbia fir.

| | Per cord. | |
|---|---|---|
| Turpentine | 7.5 | gallons |
| Tar oil | 18 | " |
| Resin | 38 | pounds |
| Charcoal | 1,338 | " |
| Pitch | 20 | " |

A plant with a capacity of 40 cords per day is about to be erected. The detailed estimates of the cost of the process and the value of products (Vancouver prices) are given in the tables opposite.

It is believed that still further economy could be gained by utilizing the inflammable gases after extracting the ammonia and acetic acid.

COST OF PRODUCTION.

| | Per cord. |
|---|---|
| Wood delivered | $2.75 |
| Electricity, $25 per kilowatt-year | 1.50 |
| Labor | 1.00 |
| Packing and other expenses | 3.50 |
| Total cost of production | $8.75 |

VALUE OF PRODUCTS.

| | |
|---|---|
| Turpentine, 6 gallons at 75 cents | $4.50 |
| Tar oil, 20 gallons at 60 cents | 12.00 |
| Resin, 60 pounds at 3 cents | 1.80 |
| Charcoal, 1,300 pounds at $20 per ton | 13.00 |
| Pitch, 20 pounds at 3¼ cents | .65 |
| Total value of products | $31.95 |

## PHOTOGRAPHIC SURVEYING FROM BALLOONS.

A DESCRIPTION OF A METHOD OF TOPOGRAPHIC SURVEYING INVOLVING THE USE OF DIRIGIBLE BALLOONS.

*Engineering.*

THE development of methods of photographic surveying from balloons, using this term to denote all appliances which move through the air or are held in it, has kept pace with neither the rapid development of photographic surveying on the one hand, nor of flying machinery of various kinds on the other. Geodetically three systems may be distinguished. When separate photographs are taken at intervals, as when the instruments are attached to captive balloons or to kites which are always swaying to and fro in the wind, the direction of the optical axis of the instrument must be determined in each case. When two photographs are taken simultaneously at the ends of a base of sufficient length, real bird's-eye views are obtained which can be combined in a stereo-comparator. The length of the base should be at least 5 yards, an awkward length for a balloon cage except with rigid airships of the Zeppelin type. The most recent system, that of the panorama view, is the invention of an Austrian officer, Captain Scheimpflug, from whose recent lectures before the Physical Society of Frankfort-on-the Main a brief description of the system is abstracted in *Engineering* for January 28.

"Captain Scheimpflug works with a special camera and other elaborate photographic apparatus of his own design; but he would appear to be able to complete a survey with a small staff and in a very much shorter time, and therefore at much smaller expense, than can be realised with the customary instruments. His panorama camera consists of a central camera with a horizontal plate and seven inclined lateral cameras surrounding the former. The cameras are rigidly connected with one another and the shutters released simultaneously, so that a very large field—he spoke of taking in an angle of 140 degrees—is secured. The first thing to be done is to produce horizontal projections of the inclined negatives. This is accomplished in a special apparatus, and the resulting panorama views show a central heptagon surrounded by seven other trapezoidal photographic sheets; the whole resembles a polygon star with seven arms, the broad bases of the trapezoids lying outward. The diameter of the circle of country represented by this polygon will be about five times the height at which the balloon and the camera were situated at the moment of exposure. In other words, a camera 500 metres above the earth will take in 5 square kilometres, or nearly 2 square miles, and so on.

"In flying over the ground, the surveyor takes photographs at rapid intervals. Thus his photographs will overlap, and it is desirable that they overlap by

more than half. The nadirs of successive photographs will be discernible on the same plate, therefore; but it will mostly be easy to fix the positions of these nadirs—that is, the point just underneath the centre of the central camera—on every picture with fair accuracy. If nadir A is in the centre of the first photograph, and nadirs B and C are further to the right, then B will be in the centre of the second photograph, and C in the centre of the third, and the picture can be oriented with the aid of the lines joining those points A, B, C. This orientation would be rigorously correct if the nadirs could exactly be determined. That is not possible, and the central camera may, moreover, not have been quite horizontal at the moment of exposure, so that the angles measured on the panorama view may not rigorously be equal to the angles, as measured by the surveyor below.

"In order to obtain a higher degree of accuracy, as large a number as possible of reference points, prominent objects in the landscape, common to three more or less overlapping panoramic views, are selected. There may be ten or twenty of these reference points. They are numbered; pieces of tracing-paper are placed over the views, and lines are drawn on the paper from the nadirs to the respective points of reference. Thus sets of three rays, diverging from the nadirs and from the points of reference, are obtained. These pieces of paper are then oriented with the aid of the nadirs and superposed, without any regard to the scale, which is still unknown. For the polygons will be similar to one another, but not equal in area, as the balloon may have changed its level in the interval between successive exposures. The superposition will, in general, show that the views do not quite coincide, but that certain triangles of error are left. As a rule, these triangles will have small areas, and coincidence may be secured with the aid of a slight shifting of the three sheets. If not, the one or other of the nadirs will have to be redetermined with all possible accuracy, and the same process gone through. Usually, however, three and more views can be oriented in this way. If it be possible afterwards to fit them into some triangulation net, the scale of the photograph will be known.

"The points of reference further admit of determining the momentary difference in height between a point of reference and the position of the balloon with regard to each of the three plates; that is to say, the actual differences between the levels of the balloon at the three moments of exposure. If this graphical determination is repeated with several points of reference, the balloon level can be fixed with sufficient accuracy. This done, the level differences of the several points of reference in the landscape can finally be ascertained. For any point of reference, which is not situated on the plane of the picture, will appear displaced, when seen obliquely from above, according to the height to which it rises above the plane, and certain proportionalities will reveal that height. This operation is performed with the aid of another apparatus—the zone transformer.

"The final result is a photographic map of the country as seen from above, on which the heights of prominent points will be marked, all originally on a small scale, which can, of course, be magnified. The apparatus is certainly expensive, and the method elaborate. On the other hand, the same outfit will serve for many surveys, and supposing airships to be built for other purposes, their utilisation for survey work would not cause great extra expense, and would not interfere with the other objects aimed at. Captain Scheimpflug concluded his lecture with giving estimates of the surveying of German South-West Africa, a territory nearly three times the size of the United Kingdom. A plane-table survey by a hundred topographers, on the scale of 1 : 25,000, he thought, would occupy 150 years or more and cost, at the lowest, ten million pounds. With the aid of his system, a dirigible, for example, of the Parseval type—rigid balloons are not required—kept at an elevation of about 1,000 metres, the mapping on a scale of 1 : 10,000 might be accomplished in fifteen years, at the ex-

penditure of two million pounds; with a larger balloon (capacity about 6,600 cubic metres), floating at the 2,000-metre level, the survey on a scale of 1 : 20,000 could be accomplished in five-and-a-half years, at a cost of less than three-quarter million pounds. A survey by means of ten captive balloons would be intermediate between the two first-mentioned estimates. These figures are probably somewhat optimistic. It is, however, more and more recognised that the photographic survey affords the best means of systematically following up slow changes in the contour of the land, and that it will therefore receive more general attention. There may be a field for photographic survey from airships, on special occasions, as well as for systematic work in the Colonies."

## THE NITRATE DEPOSITS OF CHILE.

A REVIEW OF THE ORIGIN, OCCURANCE, MINING AND COMMERCIAL IMPORTANCE OF THE NITRATE DEPOSITS.

*R. A. F. Penrose—Journal of Geology.*

THE competition of nitrogenous compounds produced as by-products in coke-oven and gas-producer operation or by fixation of the nitrogen of the atmosphere seems to have little effect on the prosperity of the Chile saltpeter industry. Production continues on an increasing scale and the price, without any of the artificial support which has been supplied by combinations and price agreements in the past few years, shows no sign of serious reduction. An interesting survey of the Chilean nitrate industry is contributed to the *Journal of Geology* for January-February by R. A. F. Penrose; the brief abstract below gives little more than an outline of Mr. Penrose's comprehensive treatment.

The deposits are located in the northern part of the country, in the region lying between 19 and 20 degrees south latitude, and mostly in the provinces of Tarapaca and Antofagasta. The Tarapaca region has been worked for a longer time, and is now worked on a larger scale, than the Antofagasta region, but the latter has great future possibilities. Although the deposits have probably been known from very remote times, nitrate mining on a commercial scale is a comparatively modern industry. The first operations of any importance are said to had been begun in Tarapaca about 1826. During the next fifty years, as new deposits were discovered and as the demand for nitrate increased, the field and the scale of nitrate mining were gradually extended; it was not, however, until the close of the war between Chile and the allies Bolivia and Peru in 1883 that the industry began to approach its present activity. The treaty of peace gave to Chile control of all the known nitrate deposits on the west coast of South America. The Chileans themselves became largely interested in the nitrate industry and capital poured into the country from England, Germany and the United States. The industry is now largely in the hands of English companies. Although Americans were among the pioneers, their operations are small compared with those of the English, Germans and Chileans.

The nitrate deposits are found at intervals in an arid region known as the pampa, at an elevation of 2,500 to 5,000 feet above the sea, which runs north and south in a long narrow belt for almost five hundred miles between the Andes on the east and the Coast Range on the west, from a few miles to over one hundred miles inland. It is of a generally flat or undulating character, studded with small rounded hills, some of them of considerable height. Its surface is dry and sandy and vegetation is almost totally absent. Rain is very rare, droughts of three or fours years' duration being of frequent occurrence. The streams flowing westward from the Andes rapidly evaporate or sink below the surface when they reach the pampa; only a few reach the sea on the surface. Occasionally in seasons of great floods

the pampa is covered with water over large areas but the normal condition of the region is one of great aridity. The very presence of the extensive deposits of soluble nitrates is evidence of the extreme dryness of the region. The surface of the pampa is composed mostly of sand, clay and gravel, with more or less rounded rock masses scattered over it, and frequent deposits of saline materials. Isolated hills and knolls of stratified and igneous rocks, similar to many of the rocks found in the adjacent mountain ranges, frequently protrude through the loose materials, and doubtless rocks of like character underlie the pampa. The surface materials are probably of post-Tertiary age and represent an old sea bottom formed by the deposition of sediments in a now extinct inland sea.

The pampa has a gentle slope from east to west; the saline materials occur at its lowest point, that is, along the western border. The deposits form beds varying in thickness from a few inches to many feet. The beds lie practically on the surface, though they are sometimes capped by earthly materials to a depth of some feet. Most of the deposits consist of common salt or of nitrate or of a mixture of the two. Other saline materials occur more sparingly. Although both common salt and nitrate occur in immense quantities, the salt is by far the more abundant and covers flats many square miles in area. The beds have not been extensively explored, the salt being used only for local consumption.

The nitrate deposits are far more important commercially. While the salt flats are usually in the very bottoms of the basins, the nitrate deposits are usually on a little higher ground. The nitrate beds are of variable thickness over even small areas; in one spot there may be several feet of the material, while within a few yards there may be only a few inches or none at all. A thickness of 1 to 1½ feet is common, of 2 to 3 feet not unusual, of 4 to 6 feet very unusual. They are usually covered by a capping composed of sand, clay, gravel and rock fragments varying in thickness from a thin coating to 40 feet. This capping is more or less indurated though the surface often shows from a few inches to a few feet of loose, wind-blown material. In some places there is a sharp line of demarcation between the capping and the nitrate; in others they seem to represent one and the same deposit, rich in nitrate at the base and poor in nitrate above, a condition which may be due to improverishment by leaching during the rare periods of flood or rainfall. Underlying the nitrate is an earthy material of a brown or buff color, and below this again is a great series of interbedded sands, clays and gravel which underlie the broad expanse of the pampa.

The nitrate occurs in the form of sodium nitrate with the formula $NaNO_3$, though very small quantities of other nitrates are sometimes found with it. The deposits seldom contain pure sodium nitrate; rarely are they 70 per cent pure. Crude nitrate containing 25 per cent of sodium nitrate is considered a fair grade of raw material and 50 per per cent is considered a high nitrate content. The impurities are sand, clay, gravel and rock fragments, with a very variable admixture of saline materials. The saline impurities are mostly common salt, sodium sulphate and calcium sulphate. In addition there occur sodium and calcium borates, as well as carbonate, chloride and other salts of calcium, various salts of aluminium, magnesium, potassium and ammonium, and a small but very constant quantity of sodium iodate. Bromine compounds and small quantities of other materials are sometimes, though rarely, present. The iodine in the crude nitrate is very important commercially, though it represents generally only a fraction of 1 per cent of the mass. It is recovered as a by-product in refining the nitrate. The borates, which occur mostly in the form of the hydrous borate of sodium and calcium or of calcium alone, have been produced in varying quantities at different times, often in very important amounts.

Many suggestions have been advanced to explain the origin of the nitrate deposits, the discussion of which involves

chiefly the source of the nitrogen. Its derivation from organic matter, and especially from guano, seems the most probable hypothesis. The coast of Chile has been gradually rising in recent geological times and the pampa region was once part of the ocean bottom. During this elevation the pampa region probably passed in succession through the conditions of an open gulf, gradually becoming more and more separated from the ocean, and later of an inland sea or a series of salt lakes. Guano beds were doubtless deposited along the borders of these waters. Guano consists largely of nitrogenous materials, phosphates and water, and while the nitrogenous materials are not originally in the form of nitrates, under suitable conditions they pass eventually into that form through the agency of certain bacteria. It seems probable that the nitrates of Chile were mostly produced in this way. Subsequently they were carried down into the waters of the basin and became mixed with the other saline materials there. As the waters gradually evaporated, the concentration of the solution increased until finally deposition of the salts began along the border and on the bottom. Eventually the whole body of water disappeared and the dry desert pampa with its deposits of nitrates, common salt, and other materials alone remained. The occurance of the nitrate in the form of sodium nitrate is probably due to the abundance of sodium salts in the region. The location of the saline deposits along the western edge of the pampa may be due to one or both of two causes, the final collection of the waters along the western border on account of the slope of the bottom, or a leaching process which has transferred materials deposited elsewhere to the location of the present deposits. The iodine was probably obtained from the decay of marine plants.

Mining in the nitrate regions is done in surface openings, usually in isolated pits or short trenches on the spots where the nitrate is richest. In some few cases, where the capping is hard and compact, or very thick, small underground workings in the form of caves have been formed, but these are the exception. Many properties have been worked over several times, lower-grade material being taken each time. In the early days, only the richest of the deposits were worked and only crude nitrate running as high as 40 or 50 per cent in sodium nitrate was mined. The average of crude material now mined in the Tarapaca region would run, perhaps, below 25 per cent in nitrate, and in certain places crude nitrate running as low as 10 per cent is utilized in admixture with higher-grade material.

The refining process consists of coarse crushing and separating the nitrate from its impurities by leaching with hot water. The refined product usually contains about 95 per cent of sodium nitrate, which is taken as the standard of purity, although a higher-grade product is sometimes made for special purposes. The method used in extracting the nitrate is very crude, and the average loss in refining in the Tarapaca region is said to be about 35 per cent. The iodine is obtained from the solution after the nitrate has been taken out by concentration of the mother liquor and treatment with sodium sulphites. The black precipitate is sublimed and condensed to the black scaly flakes of crystalline iodine. Water for the refining plants is obtained from wells, often in considerable quantities at depths of from 50 to 100 feet, or in a few cases by piping from Andean streams.

For a large part of the time in recent years most of the large nitrate producers have been in a combination which limits the output of refined nitrate and apportions to each company the amount that it may produce annually. This combination has been broken up more than once by dissentions among the producers, and as late as March, 1909, after it had been in force for several years it was again broken. Recent reports, however, are to the effect that strong efforts are being made to renew it. The price of iodine is kept up in the same way. An organization is maintained to promote the use of nitrate, especially in agriculture, and agents are kept in all the large countries of the world. As a result, the consump-

tion of nitrate is rapidly increasing. The production in 1830 was only 8,348 long tons. By 1900 the annual output had risen to 1,473,091 long tons, by 1907, to 1,780,818 long tons, and from April 1, 1908, to March 31, 1909, the production was about 1,808,986 long tons. The value of nitrate varies from year to year but the price in New York or European ports in recent years has ranged between $40 and $50 per long ton.

Estimates of the probable life of the nitrate deposits differ very widely, some predicting exhaustion in twenty-five to thirty years, others showing that the deposits will last for three or four hundred years. Many of those who predict a short life for the nitrate fields do not allow anything for future new discoveries of nitrates in northern Chile, which has not been thoroughly explored and where the probability of the existence of nitrate deposits is very great. Low-grade materials are gradually accumulating in immense quantities and may be used in the future when more economical methods are introduced. By the use of these materials, together with the aid of possible new discoveries of nitrate, Chile will doubtless be able to supply the world with nitrate for very many years to come. The nitrate of Chile is used for a large numbers of different purposes, but by far the largest consumption is for artificial fertilizer. One of its earliest uses, and still a source of large consumption, is the manufacture of niter, or potassium nitrate, for gunpowder. The nitrate of Chile is used in the manufacture of nitric acid and also, though on a much smaller scale, for many other chemical purposes.

## COLOR BLINDNESS.

THE DEFECTS OF PRESENT METHODS OF TESTING FOR COLOR BLINDNESS IN MARINE AND RAILWAY SERVICE.

*F. W. Edridge-Green—Royal Society of Arts.*

COLOR blindness plays an important part where visual signals are employed, as at sea and on railways, and the proper ability of those engaged in navigation or train operation to perceive correctly such signals is of such prime necessity that the examination of sailors and railway employees with this end in view is generally provided. Nevertheless, the underlying theory of color vision is none too perfectly understood, though to determine whether it is abnormal or deficient, there are various tests applied. According to Dr. F. W. Edridge-Green, whose recent comprehensive paper on the subject before the Royal Society of Arts is published in the *Journal* for February 11, the various tests ordinarily used for color blindness are faulty, and after developing a theory of vision and color vision, he proceeds to formulate new and more adequate tests, and to show the shortcomings of the familiar method where worsted of various colors is submitted to the person whose color vision is under test. Dr. Edridge-Green states that "cases of color blindness may be divided into two classes, which are quite separate and distinct from each other, though both may be present in the same person. In the first class there is light as well as color loss. In the second class the perception of light is the same as in the normal sighted, but there is a defect in the perception of color." The color blind may be classified in accordance with the number of colors which they see in the spectrum. If the normal sighted be designated hexachromic, those who see five colors may be called pentachromic; those who see four, tetrachromic; those who see three, trichromic; those who see two dichromic; and the totally color blind, monochromic. There are many degrees included in the dichromic, in which there may or may not be a neutral band which is widest in those cases approaching most nearly to total color blindness. Thus, in such a case only red and the extreme violet may appear to such a dichromic, while in the trichromic class which can see red, green and violet, for example, yellow may be seen as red-green and blue as violet-

green. All above the trichromic class may be grouped with the normal sighted for practical purposes, as they are not dangerously color blind and can always distinguish railway and marine signal lights correctly.

In testing for color-blindness it is desirable to know whether the defect is present or not, as by the use of a spectrometer, and then when the inquiry is made for some practical purpose, for instance, to determine whether those employed in the marine and railway services are able to recognize and distinguish between the standard red, green, and white lights, some simpler and less exact method must be used. Furthermore it is necessary to ascertain that the person being tested thoroughly understands what is meant by color, and the individual characteristics of red, green, and white respectively. Too little attention has been paid to this in constructing tests for color blindness and those who have had much practical experience in testing for this defect are aware of the ignorance which exists among uneducated persons with regard to colors. Many are under the impression that every shade of a color is a fresh color, and others have the most novel ideas with respect to color. It is necessary that a sailor or engine driver should be able to recognize a red, green, or white light by its character of redness, greenness, or whiteness respectively; that is to say, the examinee must have definite ideas of color and be able to reason with respect to them.

In constructing a test for color blindness, we must not forget the element of color ignorance, because an engine driver or sailor has to name a colored light when he sees it, not to match it. The ordinary color names red, blue, yellow and green, form excellent bases for classification. The engine-driver is told that red is a "danger" signal, green a "caution" signal, and white an "all right" signal. Therefore it is very necessary that he should know what is meant by these colors. The real object of tests for color blindness should be to exclude:

1.—Those who see three or less colors in the spectrum.

2.—Those who while being able to perceive a greater number of colors than three, have the red end of the spectrum shortened to a degree incompatible with their recognition of a red light at a distance of two miles; and

3.—Those who are unable to distinguish between the red, green, and white lights at the normal distance through insensitiveness of the retinal-nervous apparatus when the image on the retina is diminished in size.

While the dichromic regard green and red as almost, but not quite, identical, yet they are able to recognize different colors and may be able to name them with accuracy. Then all colors have not a similar degree of luminosity and it is here that many tests fail. Persons belonging to the second class should be excluded as here is a very practical form of weakness. The rays of red at the extreme left of the spectrum are the most penetrating, as may be seen by looking at a light or the sun in a foggy day, or through several thicknesses of neutral glass. The third class of color blind present interesting tests as there is no reason to exclude a man who cannot distinguish between green and gray wool, but can distinguish between standard red and green lights under service conditions, and the latter should be the basis of a practical test. Such a test has been devised by Dr. Edridge-Green, and consists of a lantern with slides containing standard red and green glass. By means of certain kinds of neutral glass the intensity and character of the light can be changed without the knowledge of the candidate. These glasses act on the colored lights like a mist or fog on distant lights, and when their intensity is diminished, they can only be distinguished with great difficulty by the color blind, while the normal sighted readily recognize colored lights even under such conditions. The neutral glasses used represent fog, the ground glass mist and the ribbed glass rain; the test is eminently practical.

The author objects to the wool test which is the official test of the British Board of Trade, first on the score of the difficulty of obtaining correctly col-

ored wools which are both uniform and permanent, and at the same time free from other differences that would afford marks of distinction to the color blind. Furthermore the relative luminosity of the colors of wools is very great, and forms a distinguishing point to the color-blind. "An ordinary red-green color blind will not put a yellow wool with a green or red one, but he will put yellow glass with green or red glass.

"The test colors used are a light-green and a light shade of rose. A red is also used as a confirmatory test. A pure green is one of the worst colors to choose for a first test. If the blue-green be removed, color-blind persons may easily pass through the list without detection."

"Whom are we to reject by this test? If we reject all the (so-called) partially red and green blind, we shall reject many persons who are practically competent. If we only reject the (so-called) completely red or green blind, we shall allow many persons who are dangerously color-blind to officiate as signal men." The test is more theoretical than practical, and in the author's experience an ignorant pentachromic or tetrachromic color-blind (that is, a person who is partially color-blind, but not color-blind to an extent necessitating his rejection) is more likely to fail than an educated dichromic (red-green color-blind). A person with central scotoma or insensitiveness to color when occupying a small portion of the field of vision, will escape detection if examined by this test.

"As a light at a distance occupies the central portion of the field of vision, these persons will be found to recognize colors when close to them, but not when they are at a distance. The red end of the spectrum may be considerably shortened, so much so that a person may scarcely be able to distinguish red from black. It is obvious that this will not prevent him from matching a light green with other wools. It is not by any means an efficient test. We cannot reject by it those persons who would be dangerous as sailors or engine drivers, and only those persons." It is not a difficult task to instruct a red-green color-blind to meet this test successfully and many dangerously color-blind men have been passed by it. In the Board of Trade report for 1908 it is stated that of those who were rejected by the wool test and who appealed over 53 per cent. were found to be normal sighted, and to have been rejected wrongly. Dr. Edridge-Green believes that the test has been a failure and that the facts in connection with it should be carefully investigated.

## THE HUDSON BAY RAILWAY.

A BRIEF OUTLINE OF THE PROJECT AND AN ESTIMATE OF THE COST AND TRAFFIC POSSIBILITIES OF THE HUDSON BAY ROUTE.

*Engineering News.*

THE establishment of a port on Hudson Bay and the construction of a railway thereto to assist the development of the great Canadian Northwest is a very old scheme. There are grave objections to the project, all based on the high latitude of the entrance to Hudson Bay, which include the short season of navigation (three to four months) and the difficulties and dangers of navigation due to ice. The entrance of Hudson Straits into Hudson Bay lies far north of latitude 60 degrees, and even during the open season navigation is endangered by ice floes, fogs and contrary currents. The Canadian Government, however, now stand committed to the work of building the railway and the Minister of Railways has promised that construction will be pressed with all possible speed. A brief review of the project is taken from an article in *Engineering News* for March 3.

The chief advantage of the Hudson Bay route lies in the fact that the distance from Fort Churchill to Liverpool (passage north of Ireland) is about

3,200 miles, as compared with 3,000 miles Montreal to Liverpool. Until within the past few years the Hudson Bay Railway has been projected as part of a commerce route starting from Winnipeg, the starting point of all rail and rail-and-lake routes to the seaboard. With the great development of the Northwest and its railway systems, however, an important change has been made in the project by which Winnipeg will be eliminated and freight will be shipped by more direct rail routes from the northwest districts to Hudson Bay. The starting point now proposed for the Hudson Bay Railway is "The Pas" on the Saskatchewan River, which is now reached by the Canadian Northern Railway and to which other lines are projected.

During the winter of 1908-9, lines were surveyed from "The Pas" reaching both Fort Churchill and Port Nelson on Hudson Bay. "For the Fort Churchill route (477 miles) the first 120 miles would be comparatively level country, with a considerable amount of swamp; the next stretch of 120 miles would be in granite country, involving a number of rock cuttings. The heaviest work would be in the third stretch of 120 miles, which includes the rise between the basins of the Nelson and Churchill rivers, with heavy rolling country which necessitates considerable development of the line to keep the prescribed grades. On the fourth section the earthwork will probably be light, but the crossing of the tundra or low barren swamps bordering on the bay (70 miles) may prove more expensive than the easy profile would indicate. The grades are 0.4 per cent. against northbound traffic and 0.6 per cent. against southbound traffic. The curvature averages 10 degrees per mile. The Port Nelson route (410 miles) diverges from the other route near Split Lake, about 120 miles from "The Pas"; it does not strike the barren lands, but is in timber country throughout. The maximum grades are the same, but the curvatures averages only 5.5 degrees per mile.

"The Churchill route would have to be operated in four locomotive divisions of about 120 miles each; but on the Port Nelson route (owing to the easier grades) the engines could operate three divisions of 135 miles each. Thus five engine terminal facilities would be required on the former and four on the latter route." The estimated costs of the two routes provide for passing tracks and telegraph stations at intervals of five miles, water stations at intervals of 15 miles, and roundhouse and shop accommodation sufficient to care for the equipment necessary for 32 freight trains and one fast passenger train every 24 hours. The estimated cost of the Fort Churchill route is $19,108,672; of the Port Nelson route, $16,426,340. The allowance for equipment is $9,000,000 in each case. For harbor work $6,675,000 is allowed in the case of the Fort Churchill route and $5,065,000 in the case of the Port Nelson route, making the total estimates, respectively, $34,783,672 and $30,491,340.

"The Port Nelson route is considered the preferable; it is shorter, the construction work is easier and the port conditions are better. A fair proportion of the route is also considered available for settlement, while there is no probability of settlement on the Churchill route north of its junction with the Port Nelson route."

According to a report by M. J. Butler, Deputy Minister of Railways and Canals, the whole of Alberta and Saskatchewan with the exception of about 11,000 square miles in the latter province will be tributary to the Hudson Bay route. Locomotives of the Mallet type with a hauling power of at least 4,000 tons of pay load are to be employed. Allowing 16 loaded trains per day for 30 days, it is estimated that 64,000,000 bushels of wheat will be moved per season, requiring 135 to 140 ships if two trips are allowed to each ship. Other sources of traffic possible to the line are the exportation of cattle, package freight to and from Europe and an import coal trade with Nova Scotia. The possible saving in grain traffic is estimated at 5 cents per bushel, assuming that insurance and freight rates are equal at Port Nelson and Montreal.

# THE ENGINEERING INDEX

"THE KEYSTONE IN THE ARCH OF APPLIED SCIENCE"

The following pages form a *descriptive* index to the leading and special articles of permanent value published currently in the Transactions of all the important engineering societies of both Europe and America, and in all the leading engineering journals of the world—in the English, French, German, Dutch, Italian, and Spanish languages.

The term *descriptive* is used because the definite purpose of each index note is to indicate clearly the character and purpose of the article or paper described; and with that in view we give the following essential information about every publication:

(1) The title of the article,
(2) The name of its author,
(3) A descriptive abstract,
(4) Its length in words,
(5) Where published,
(6) When published,
(7) *We supply the article itself, if desired.*

☞ The full text of every article described in the Index, together with all its illustrations, can usually be supplied by us.—See the "Explanatory Note" at the end of the Index, where also the full titles of the principal journals indexed are given.

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NOTE—The busy engineer will also observe that the Index is conveniently classified into the larger divisions of engineering science, to the end that the reader may quickly turn to what concerns himself and his special branches of work. By this means it is possible, within a few minutes' time each month, to learn promptly of every important article published anywhere in the world, in any language, upon the subjects claiming one's special interest.

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DIVISIONS OF THE ENGINEERING INDEX.


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| ELECTRICAL ENGINEERING | " 126 | MINING AND METALLURGY | " 146 |
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## CIVIL ENGINEERING.

### BRIDGES.

**Abutments.**

A Pier Type of Abutment for Highway Bridges. Illustrates and describes abutments adopted on the Barge Canal. 1000 w. Eng Rec—Feb. 5, 1910. No. 11482.

**Bascule.**

Bascule Bridge at Copenhagen. Illustrated description of the new bridge, of the double-bascule type, over the harbor channel. 1000 w. Engr, Lond—Feb. 4, 1910. No. 11622 A.

Emergency Repairs to a Bascule Drawbridge Over the Chicago River; Chicago Terminal Transfer Ry. F. H. Avery. Explains the damage caused by the bridge being struck by a steamer and describes the repairs. Ills. 2500 w. Eng News—Feb. 3, 1910. No. 11411.

See also Timber, under BRIDGES.

**Cantilever.**

Great Bridge Over the Red River in Indo-China. Illustrated description of a fine cantilever railroad bridge, erected by

*We supply copies of these articles. See page 158.*

French engineers. 900 w. Sci Am Sup—Feb. 5, 1910. No. 11406.

**Erection.**

Erection Appliances for the Belly River Viaduct at Lethbridge, Alberta. Illustrates and describes the mechanical appliances used in erecting this high viaduct. 1200 w. Eng News—Feb. 24, 1910. No. 11874.

**Floors.**

The Cost of Bridge Floors. Gives a comparison of three types of jack arch floor construction as to economy. 3500 w. Engr, Lond—Jan. 28, 1910. No. 11541 A.

**Masonry.**

See Repairing, under BRIDGES.

**Moving Loads.**

A New Moment Table. C. R. Young. Gives a new table with the object of shortening calculations for shear and moment due to moving locomotive and train loads. 1000 w. Ap Sci—Jan., 1910. No. 11825 C.

**Quebec.**

The Design for the New Quebec Bridge. Line drawings and criticism of the proposed plans. 1500 w. Sci Am—Feb. 12, 1910. No. 11549.

**Reinforced Concrete.**

Design and Cost of Reinforced-Concrete Highway Bridges. A. N. Johnson. Abstract of a paper presented at meeting of the Ill. Soc. of Engrs. & Surv. Gives data concerning work done in 1909. 2200 w. Eng News—Feb. 10, 1910. No. 11521.

Some Cost Data for Reinforced-Concrete Highway Bridges. A. N. Johnson. Read before the Ill. Soc. of Engrs. & Surv's. Explains what control the State Highway Commission in Illinois has over bridge work, and gives cost data of concrete bridges built in 1909. 3000 w. Eng Rec—Feb. 5, 1910. No. 11478.

Method and Cost of Reinforced Concrete Highway Bridge Construction. Under the Direction of the Illinois Highway Commission. Rearranged from a paper by A. N. Johnson, read before the Ill. Soc. of Engrs. & Surv. Gives reasons why nearly all their concrete bridges are of the girder type and information concerning them. 3000 w. Engng-Con—Feb. 2, 1910. No. 11424.

The Construction of the Evanston Subway Bridges, Chicago, Milwaukee & St. Paul Railway. E. O. Greifenhagen. Illustrates and describes the construction of the piers and abutments and of the slabs. 3500 w. Eng Rec—Feb. 5, 1910. No. 11477.

The Design of the Evanston Subway Bridges, Chicago, Milwaukee & St. Paul Railway. E. O. Greifenhagen. An illustrated detailed description of the design of these bridges, considered under the headings of piers, abutments, and slabs. 3000 w. Eng Rec—Jan. 29, 1910. No. 11315.

The Governor Reynolds Reinforced-Concrete Bridge, Province of Albay, Philippine Islands. Oliver D. Filley. Illustrated description of a bridge built by American engineers. 1500 w. Eng News—Feb. 17, 1910. No. 11647.

Concrete Arch Railway Bridge over the Ulster (Eisenbahnbogenbrücke aus Beton über die Ulster). Herr Winter. Illustrated description. 2000 w. Beton u Eisen—Jan. 28, 1910. No. 11907 D.

**Repairing.**

Repairs to a bridge on the Boves-Ailly-sur-Noye Line (Note sur la Réfection du Pont au-dessus du Chemin de grande Communication No. 90 de Boves à Ailly-sur-Noye). H. Bouchard. Illustrated description of repairs to a masonry arch. 1500 w. Rev Gen d Chemins de Fer—Jan., 1910. No. 11712 G.

**Steel.**

The Liao River Railway Bridge, Manchuria. Illustrated detailed description of the erection by Chinese workmen of a 20-span girder bridge on concrete piers. 2000 w. Engng—Jan. 21, 1910. No. 11386 A.

Boylston Street Bridge, Boston, from 1888 to the Present Time. Frederic H. Fay, Charles M. Spofford and John C. Moses. An outline of the construction, history, destruction, and reconstruction of a bridge subjected to locomotive fumes and increasing street car loads. Ills. Discussion. 12800 w. Jour Assn of Engng Socs—Dec., 1909. No. 11959 C.

Types of Highway Bridges. F. Barber. First of a series of articles giving illustrations and describing the writer's idea of the kind of bridge suitable for particular locations. 1500 w. Can Engr—Feb. 18, 1910. Serial. 1st part. No. 11805.

The Calculation of the Vehicle and Foot Ways of Steel Highway Bridges (Beitrag zur Berechnung der Fahrbahn und Fusswege eiserner Landstrassenbrücken). W. Schulz. Mathematical demonstration of method. Ills. Serial. 1st part. 1500 w. Elektrotech Rundschau—Jan. 12, 1910. No. 11912 D.

The Beeringen Bridge (Le Pont de Beeringen). A. Vierendeel. Mathematical demonstration of the method of design of a girder bridge of a new type. Ills. 9000 w. All Indus—Jan., 1910. No. 11726 D.

**Timber.**

The Fosdyke Bridge. Illustrates and describes the old timber bascule bridge over the river Willand, soon to be replaced by a steel swing bridge. 800 w. Engr, Lond—Feb. 11, 1910. No. 11846 A.

**Trestles.**

The Albemarle Sound Trestle of the Norfolk & Southern Railway. F. L. Nich-

*We supply copies of these articles. See page 158.*

olson. Map and illustrated description of a pile trestle having two large movable spans for the accommodation of navigation, and five fixed spans. 2000 w. Ry Age Gaz—Feb. 25, 1910. No. 11952.

**Viaducts.**

See Erection, under BRIDGES.

## CONSTRUCTION.

**Beams.**

Deflection of Beam Uniformly Loaded for Part of Its Length. George E. Barrett. Mathematical determination. 300 w. Mach, N Y—Feb., 1910. No. 11346 C.

**Columns.**

Proportioning Latticed Columns by Weight per Foot. Benton Lattin. Discusses the influence of the lacing ratio, and of the length ratio, and the effect of diaphragms. 1000 w. Eng News—Feb. 24, 1910. No. 11878.

**Concrete.**

A Concrete House with Untreated Surface. Illustrated description of a house at Ocean City, N. J., especially advocating the untreated walls. 3000 w. Cement Age—Feb., 1910. No. 11806.

Concrete Work in the Chelsea Dock Improvements, New York City. Illustrated description of the great wall of reinforced concrete recently constructed along the North River from Little West 12th to 23d street. 700 w. Cement Age—Feb., 1910. No. 11807.

Concrete Construction on the Panama Canal. Brief illustrated description of methods used in handling the concrete. 800 w. Sci Am—Feb. 19, 1910. No. 11650.

**Concrete Blocks.**

Industrial Chimneys and Water Towers of Concrete Blocks. H. Prime Kieffer. Illustrations of work in Belgium, describing the system invented by M. Dumas. 1200 w. Sci Am—Feb. 19, 1910. No. 11651.

See also Shafts, under MINING AND METALLURGY, MINING.

**Cost Systems.**

See same title, under INDUSTRIAL ECONOMY.

**Earthwork.**

See Construction, under RAILWAY ENGINEERING, PERMANENT WAY AND BUILDINGS.

**Fireproof.**

Fire Protection in San Francisco Under the New Building Law. A summary of the fireproofing and fire-protection provisions. 2500 w. Eng News—Feb. 10, 1910. No. 11515.

The Fire Tax and Waste of Structural Materials in the United States. Herbert M. Wilson and John L. Cochrane. An investigation of materials used in construction work, giving statistics of interest. 8000 w. U S Geol Surv—Bul. 418. No. 11698 N.

**Floors.**

Floor Construction Over Large Halls in High Buildings (Deckenkonstruktionen für Saalbauten in Etagenhäusern, insbesondere bei Hotelbauten). O. Leitholf. Gives a number of examples of floors over large rooms. Ills. Serial. 1st part. 3000 w. Deutsche Bau—Jan. 5, 1910. No. 11773 B.

**Foundations.**

See Piling, under CONSTRUCTION.

**Hydraulic Filling.**

Methods and Cost of Hydraulic Filling at Cairo, Ill. Jean M. Allen. Describes notable work. Ills. 2000 w. Engng-Con—Feb. 16, 1910. No. 11659.

**Piling.**

Interlocking Steel and Concrete Pile Construction for Seawalls and Foundation Work. Illustrated description of this system as used in Chicago. 1400 w. Eng News—Feb. 3, 1910. No. 11408.

Concrete Pile Foundation for the Evansville Filters. F. H. Stephenson. States the conditions and describes the plan and methods adopted. Ills. 1500 w. Eng Rec—Feb. 19, 1910. No. 11685.

**Reinforced Concrete.**

Industrial Applications of Reinforced Concrete. M. M. Sloan. This third article of a series continues the discussion of structural details of roofs, skylights, stairs, etc. Ills. 1200 w. Engineering Magazine—March, 1910. No. 11976 B.

Uses of Reinforced Concrete in Railway and Power House Work. F. W. Scheidenhelm. An outline of the possibilities of this material in certain fields of construction work. Ills. 3500 w. Elec Jour—Feb., 1910. No. 11998.

Railway Station Platform Roofs in Reinforced Concrete (Bahnsteigdächer aus Eisenbeton). Herr Francke. Describes a number of types of construction used on the Prussian State Railways. Ills. 1500 w. Deutsche Bau—Jan. 12, 1910. No. 11774 B.

What Consideration Should Be Given to Continuity in Reinforced Concrete Beams and Slabs. M. E. Thomas. Discusses the reason for the variation existing in present practice of calculating binding moments and what are the theoretical moments that would guide a designer. Ills. 1000 w. Engng-Con—Feb. 23, 1910. No. 11871.

A Condition of Economy in Reinforced-Concrete Construction (Note sur une Condition d'Economie du Béton armé). A. Detœuf. Mathematical discussion of economy in reinforcement. Ills. 3300 w. Tech Mod—Jan., 1910. No. 11717 D.

The Calculation of Vierendeel Beams (Beitrag zur Berechnung von Vierendeelträgern). A. Ostenfeld. Mathematical. Ills. 7000 w. Beton u Eisen—Jan. 28, 1910. No. 11908 D.

*We supply copies of these articles. See page 158.*

The Calculation of Concrete Beams with Spiral Reinforcement (Zur Berechnung der Eisenbetonbalken mit spiralarmierter Druckzone). Paul Frei. Mathematical discussion. Ills. 1200 w. Zeit d Oest Ing u Arch Ver—Jan. 7, 1910. No. 11794 D.

Graphical Design of Continuous Beams (Beitrag zur graphostatischen Behandlung Kontinuierlicher Träger). B. Löser. Mathematical discussion and tabular data. Ills. 4000 w. Beton u Eisen—Jan. 7, 1910. No. 11905 F.

See also Stacks, under CONSTRUCTION; Aqueducts, under WATER SUPPLY; and Timbering, under MINING AND METALLURGY, MINING.

**Retaining Walls.**

Design of Retaining Walls for the Steptoe Smelter. S. Severin Sörensen. Illustrated description of the standard design used in constructing this large plant in Nevada. 1000 w. Eng Rec—Feb. 19, 1910. No. 11680.

**Specifications.**

Precarious Expedients in Engineering Practice. John Hawkesworth. Describes methods of preparing plans and specifications and the awarding of contracts, exposing facts and suggesting remedies. 5000 w. Pro Am Soc of Civ Engrs—Jan., 1910. No. 11956 E.

**Stacks.**

Reinforced Concrete Chimney Construction. Ernest R. Matthews. Abstract of paper before the Concrete Inst. Considers the advantages of this material, the erection, methods of calculating stresses, effect of excessive heat, etc. 2800 w. Surveyor—Jan. 21, 1910. No. 11381 A.

Methods of Putting a Reinforced Concrete Jacket on a Cracked Chimney. Illustrated description of work at New Haven, Conn., consisting of molding a jacket 5-ins. thick about a cracked and leaky chimney. 900 w. Engng-Con—Feb. 16, 1910. No. 11658.

See also Concrete Blocks, under CONSTRUCTION.

**Steel.**

A Large Steel Frame Rolling Mill Building. Illustrated detailed description of special structural features of a recent addition to the Jones & Laughlin works, Pittsburgh, Pa. 2500 w. Eng Rec—Jan. 29, 1910. No. 11314.

The Ritz-Carlton Hotel. Plans and description of this steel-frame structure in New York City, having 4 stories below and 15 above street level. 1200 w. Eng Rec—Feb. 12, 1910. No. 11586.

**Tunnels.**

Tunnels, Particularly Subaqueous. R. B. Woodworth. Gives a brief historical review of tunnels, their classification; illustrating and describing methods of construction, especially of subaqueous work. 22500 w. Pro Ry Club of Pittsburgh—Dec. 22, 1909. No. 11814 C.

The New York Tunnel Extension of the Pennsylvania Railroad. North River Division. Charles M. Jacobs. An outline of the scheme of bringing the Penn. R. R. and Long Is. R. R. into N. Y. City, recording leading features on the work of this division. Ills. 7500 w. Pro Am Soc of Civ Engrs—Jan., 1910. No. 11957 E.

See also same title, under WATER SUPPLY.

## MATERIALS OF CONSTRUCTION.

**Cement.**

Experiments on the Coarser Particles in Cement. George Sydney Brinckley. A report of tests made giving deductions. Ills. 1500 w. Eng Rec—Feb. 19, 1910. No. 11681.

**Concrete.**

The Scientific Practice of Concrete. Rolf R. Newman. On the development of this material and its present use. 900 w. Cement Age—Feb., 1910. No. 11808.

The Coefficient of Elasticity of Concrete in Shear. Investigates the deflection due to bending, and gives computation for determining the coefficient of elasticity. 1000 w. Cement—Feb., 1910. No. 11802 C.

Tests on the Permeability of Concrete. F. M. McCullough. Reports a series of tests made to determine the efficiency of some of the commercial compounds used for waterproofing concrete. Ills. 4000 w. Wis Engr—Feb., 1910. No. 12007 D.

Tests of Concrete Columns Made Under Building Conditions. H. C. Berry. Illustrated description of tests made by the Civil Engng. Dept. of the Univ. of Penn., discussing results. 2500 w. Eng Rec—Feb. 19, 1910. No. 11679.

The Destruction of Concrete by Hydrogen Sulphide Gas (Betonzerstörung durch Schwefelwasserstoffgas). Erich Stephan. A discussion of the chemical reactions by which concrete is injuriously affected by hydrogen sulphide fumes. 3000 w. Beton u Eisen—Jan. 7, 1910. No. 11906 F.

**Steel.**

Some Deductions from Marburg's I-Beam Tests. A critical analysis by C. J. Tilden of certain facts reported in connection with recent tests of steel I-beams, with reply by Edgar Marburg. Ills. 2500 w. Eng News—Feb. 24, 1910. No. 11881.

**Timber.**

The Protection of Submarine Structures. Gen. W. A. Jones. Considers preventive measures against living forms and rust in submerged structures. Ills. 2200 w. Engineering Magazine—March, 1910. No. 11980 B.

The Forest Products Laboratory—Its Work and Equipment. McGarvey Cline. An account of a laboratory for studying problems for eliminating waste and bring-

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ing about greater economy in the use of wood. 2200 w. Wis Engr—Feb., 1910. No. 12006 D.

**Timber Preservation.**

Treating Timber with Crude Petroleum. C. Marshall Taylor. Abstract of a paper read before the Wood Preservers' Assn. A brief résumé of the crude petroleum treatments. 800 w. Eng News—Feb. 3, 1910. No. 11412.

Economical Wood Preservation. Robert Hays. A report of tests to obtain figures relating to the comparative absorption of creosote when the treatments were commenced with hot baths of petroleum and creosote; also the use of salt-water. 1800 w. Ry Age Gaz—Jan. 28, 1910. No. 11303.

## MEASUREMENT.

**Surveying.**

Surveying the Public Land of the United States. H. W. MacFarren. Explains the method of surveying and subdividing the public land. 3500 w. Min & Sci Pr—Jan. 29, 1910. No. 11447.

## MUNICIPAL.

**Drainage.**

Design and Construction of Open Ditches to Reduce Maintenance with a Description of Methods of Maintenance and Some Costs. E. H. Cowan. Read before the Ill. Soc. of Engrs. & Surv. 1800 w. Engng-Con—Feb. 2, 1910. No. 11426.

**Refuse Disposal.**

Town Scavenging and Refuse Disposal. Hugh S. Watson. Describes special street-cleaning services in England. 2500 w. Munic Engng—Feb., 1910. No. 11994 C.

The Collection and Disposal of Refuse in the City of Boston, Mass. Concerning the recommendations of a special commission, with consideration of present methods and costs. 4500 w. Eng News—Feb. 10, 1910. No. 11520.

**Roads.**

The Dust-Nuisance in Australia. An account of the conference of municipalities convened at Melbourne with the object of discussing the prevention or abatement of the dust-nuisance. 5500 w. Surveyor—Jan. 28, 1909. No. 11531 A.

Bituminous Highway Construction. Clarence A. Kenyon. Read before the Indiana Engng. Soc. Reviews what has been accomplished by experimenters. 2500 w. Munic Engng—Feb., 1910. No. 11996 C.

The Use of Tar for Road-Making and Repairs. William Wade. Read before the Inst. of Munic. Engrs. States present requirements, and discusses methods of using tar as a binder, favoring tar grouting as giving the best road for mixed traffic. 2500 w. Surveyor—Jan. 21, 1910. Serial. 1st part. No. 11382 A.

Tar as Applied to the Surface Treatment of Roads. Hervey J. Skinner. Read before the Am. Gas Inst. Also discussion. Gives results of an investigation carried out at the Little Laboratory, Boston. 7500 w. Am Gas Lgt Jour—Feb. 19, 1910. No. 11556.

Work of the Massachusetts Highway Commission in 1909. Information from the last report on road construction and maintenance. 3000 w. Eng Rec—Feb. 5, 1910. No. 11479.

**Sewage Disposal.**

The Hampton Doctrine in Relation to Sewage Purification. K. Imhoff. Reply to an article by W. Owen Travis. A technical discussion of the Emscher tanks and their relation to other systems. Ills. 4500 w. Surveyor—Feb. 4, 1910. No. 11604 A.

Purification of Sewage for Power Plant Purposes. Describes the system used at works of the Allis-Chalmers Co., when the limited supply of water made it necessary to utilize the effluents for condensing water. Ills. 1200 w. Eng Rec—Feb. 19, 1910. No. 11682.

Modern Methods of Sewage Disposal. T. Aird Murray. An illustrated address giving deductions from present knowledge. 3500 w. Ap Sci—Jan., 1910. No. 11824 C.

Sewage Disposal Works, Grand Canyon, Arizona. Illustrates and describes a plant serving two hotels located where there is no adequate source of water supply, so the effluent is used as boiler water. 1200 w. Eng Rec—Jan. 29, 1910. No. 11319.

The Greater Pittsburg Sewerage and Sewage Purification Orders. Abstracts of three orders or permits issued to the city of Pittsburg, with editorial discussion. 6500 w. Eng News—Feb. 10, 1910. No. 11522.

The Sewerage Problem of Greater Pittsburgh. Explains the general conditions governing the sewerage and drainage of the city as outlined in a recent decree of the Commissioner of Health. 3500 w. Eng Rec—Feb. 12, 1910. No. 11585.

See also Columbus, O., under WATER SUPPLY.

**Sewage Filters.**

The Design of Small Intermittent Sewage Filters. Suggestions from a paper by Paul Hansen, before the Ohio Engng. Soc., regarding the design of small plants. 2500 w. Eng Rec—Feb. 19, 1910. No. 11687.

**Sewers.**

Brooklyn's Bureau of Sewers. Illustrated article describing the laboratory for testing sewer pipe, and methods used; explaining the percentage system of bidding, etc. 5500 w. Munic Jour & Engr—Feb. 2, 1910. No. 11423.

Difficult Construction of Concrete Sewer. Maury Nicholson. Illustrates and describes work at Birmingham, Ala., explaining conditions. 1500 w. Munic Jour & Engr—Feb. 9, 1910. No. 11501.

*We supply copies of these articles. See page 158.*

Concrete Sewers at Richmond, Ind. Frederic R. Charles. Abstract of a paper before the Ind. Engng. Soc. Recent work is described, of monolithic construction. 1200 w. Eng News—Feb. 3, 1910. No. 11409.

Sewer Construction in Baltimore. A Thousand Miles of Sewers. An illustrated account of the extensive system now under construction, and its features of special interest. 4500 w. Munic Jour & Engr—Feb. 2, 1910. No. 11422.

See also Floods, under WATER SUPPLY.

**Sidewalks.**

Methods and Costs of Sidewalk Construction in Chicago. Condensed from a paper by N. E. Murray, read before the Ill. Soc. of Engrs. & Surv. Deals with cinder and cement walks. 2200 w. Engng-Con—Feb. 2, 1910. No. 11427.

**Street Cleaning.**

See Refuse Disposal, under MUNICIPAL.

## WATER SUPPLY.

**Aqueducts.**

Design of and Method of Constructing a Reinforced Concrete Aqueduct Lining, with Some Data on Costs. Describes construction details on aqueducts of the Illinois and Mississippi Canal. 2500 w. Engng-Con—Feb. 2, 1910. No. 11425.

**Artesian.**

Comments on Artesian Wells. F. J. Warden-Stevens. Deals with mechanical details relating to water supply from artesian wells. 1200 w. Archt, Lond—Jan. 21, 1910. No. 11360 A.

**Columbus, O.**

The Improved Water and Sewage Works of Columbus, Ohio. John H. Gregory. Illustrated detailed description of two important sanitary improvements recently completed, including works for improving the water supply, and for purifying the dry-weather flow of sewage. 31500 w. Pro Am Soc of Civ Engrs—Jan., 1910. No. 11955 E.

**Conduits.**

See Dams, under WATER SUPPLY.

**Dams.**

The Maiden Creek Filters, Dam and Conduit at Reading, Pa. Illustrated description of a concrete dam, a 60-in. circular reinforced concrete conduit, and 10 slow-sand beds. 2000 w. Eng Rec—Feb. 5, 1910. No. 11483.

Construction of Reinforced-Concrete Dam at Fredericksburg. Illustrates and describes a dam consisting of an inclined deck supported by buttresses. 1500 w. Eng Rec—Feb. 12, 1910. No. 11589.

Some Notes in Connection with the Construction of a Concrete Dam on the Trent Canal. J. B. Brophy. Illustrates and describes methods used in constructing an important work. 1200 w. Can Engr—Feb. 18, 1910. No. 11804.

Storage Curves (Staukurve). Leo Bloudek. Discusses mathematically the method of determining the curve of the surface of water stored by a dam. Ills. 3500 w. Oest Wochenschr f d Oeffent Baudienst—Jan. 22, 1910. No. 11902 D.

**Edmonton.**

Pigeon Lake Gravity Water Supply. H. L. Seymour. Describes the conditions and engineering details of the gravity supply for Edmonton, Alberta, Canada. 2000 w. Can Engr—Feb. 4, 1910. No. 11485.

**Filtration.**

See Dams, under WATER SUPPLY.

**Fire Protection.**

See Fireproof, under CONSTRUCTION.

**Irrigation.**

Field Location of Canals for Irrigation. L. R. Balch. Brief outline of methods. Ills. 1200 w. Wis Engr—Feb., 1910. No. 12009 D.

See also Pumping Plants, under MECHANICAL ENGINEERING, HYDRAULIC MACHINERY.

**New York City.**

Waste in New York's Water Supply. Joseph Wood, Jr. Remarks on the danger of water shortage, the enormous waste, and its causes, and means of checking the loss. Ills. 3000 w. Yale Sci M—Feb., 1910. No. 11954 C.

**Pipe Design.**

The Calculation of Large Pipes (Beitrag zur Berechnung weiter Rohre). Otto Frohlich. Discusses the design of pipes for several special types of loading. Mathematical. Ills. 4000 w. Zeitschr d Oest Ing u Arch Ver—Jan. 21, 1910. No. 11796 D.

**Pipe Lines.**

The Steel Pipe Lines and River Crossing, Little River Water Supply, Springfield, Mass. Illustrates and describes work in connection with the new water supply. 3300 w. Eng Rec—Feb. 19, 1910. No. 11686.

**Pollution.**

The Character of Stream Pollution as Affecting Purification Plant Design. H. E. Jordan. Read before the Indiana Engng. Soc. Describes water purification plants that have had to solve different problems. 2500 w. Munic Engng—Feb., 1910. No. 11997 C.

**Purification.**

The Treatment of Water Antecedent to Filtration. Walter Clemence. Considers the action of a sand filter and discusses reasons which render necessary some previous treatment of the water, describing the various processes of treating river water. Ills. 5000 w. Engng—Jan. 28, 1910. Serial. 1st part. No. 11540 A.

Water Purification for Ice and Refrigeration Plants. J. C. William Greth. Read before the Am. Soc. of Refrig. Engrs. Gives results of experimental re-

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search and useful tables and details. 6000 w. Ice & Refrig—Feb., 1910. No. 11444 C.

The New Coagulating Works of the St. Louis Water Department. Illustrated detailed description of the plant employed for adding sulphate of iron and lime to the Mississippi River water. 5000 w. Eng Rec—Feb. 12, 1910. No. 11584.

The Ultra-Violet Rays and Their Application to the Sterilization of Liquids (Les Rayons ultra-violets et leur Application à la Sterilisation des Liquides). Th. Nogier. The first part introduces a general discussion of the properties of the ultra-violet rays. Ills. Serial. 1st part. 1700 w. Tech Mod—Jan., 1910. No. 11718 D.

See also Pollution, under WATER SUPPLY.

**Tunnels.**

The Design of Pressure Tunnels of the Catskill Aqueduct. Notes from a paper by Thomas H. Wiggin, describing the deep, concrete lined tunnels which are to be subjected to hydrostatic pressure. 3500 w. Eng Rec—Jan. 29, 1910. Serial. 1st part. No. 11318.

Method of Making Watertight by Grouting the Yonkers Pressure Tunnel (Siphon) of the Catskill Aqueduct. Illustrated descriptive outline of the scheme for rendering the tunnel lining impervious to water. 1500 w. Engng-Con—Feb. 9, 1910. No. 11510.

**Water Towers.**

See Concrete Blocks, under CONSTRUCTION.

**Weirs.**

The Rolling Weir at Poppenweiler on the Neckar and Rolling Weirs in General (Das Walzenwehr im Neckar bei Poppenweiler und die Walzenwehre in Allgemeinen). Illustrated description. Serial. 1st part. 1800 w. Deutsche Bau—Jan. 29, 1910. No. 11775 B.

## WATERWAYS AND HARBORS.

**Canals.**

Royal Commission on Canals and Waterways. Digest of the portion of the report referring to England and Scotland of interest to the coal trade. 2500 w. Col Guard—Jan. 21, 1910. Serial. 1st part. No. 11534 A.

Canal Improvement as Affecting Municipalities. H. C. H. Shenton. Discusses the proposals of the Royal Commission on Canals. 1600 w. Surveyor—Jan. 28, 1910. No. 11530 A.

The Danube-Save Canal and the Waterway to the Adriatic (Daten zur Frage des Danau-Save-Kanals und der zum Adriatischen Meere führenden Wasserstrasse). A technical outline of the project. Ills. 5500 w. Oest Wochenschr f d Oeffent Baudienst—Jan. 1, 1910. No. 11798 D.

**Dry Docks.**

See Dock Machinery, under ELECTRICAL ENGINEERING, POWER APPLICATIONS.

**Floods.**

The Influence of Forests on Climate and on Floods. Willis L. Moore. Gives facts and figures based on careful study and presents conclusions. Maps. 16000 w. U S Com on Agri—1910. No. 11699 N.

The Great Paris Flood. Many illustrations, with remarks taken from the *N. Y. Sun*. 500 w. Sci Am Sup—Feb. 26, 1910. No. 11884.

The Floods in the Seine. Editorial and map showing the destruction caused at Paris and its outskirts. 3500 w. Engng—Feb. 4, 1910. No. 11616 A.

Paris and Its Tunnels. Illustrated description of the tunnels in Paris which have been affected by the recent inundation. 2500 w. Sci Am Sup—Feb. 5, 1910. No. 11407.

The Water Supply. Sewerage and Subways of Paris in Relation to the Present Floods. George A. Soper. Considers the hydrology of the Seine, the subterranean structures, the population and city plan, the dual water-supply, sewers, sewage farms, subways and underground railways, and the danger of epidemic. Ills. 6000 w. Eng News—Feb. 3, 1910. No. 11414.

**Havre.**

The Port of Havre (Le Port de Havre). A. Guiffart. The first part discusses generally the condition of the port and projected improvements. Ills. Serial. 1st part. 6500 w. Génie Civil—Jan. 15, 1910. No. 11735 D.

**Inland Navigation.**

Railways and Navigable Waterways (Les Chemins de Fer et les Voies Navigables). Abstracts of papers in the Bul. Int. Ry. Congress for Nov., 1909, dealing with the relation between railways and waterways in Europe. Ills. 6500 w. Génie Civil—Jan. 8, 1910. No. 11733 D.

**Marine Borers.**

See Timber, under MATERIALS OF CONSTRUCTION.

**Panama Canal.**

The Panama Canal. George W. Goethals. Read before the Engng. Soc. of the British Assn. at Winnipeg. An illustrated general description of the engineering and constructional features. 5000 w. Engng—Feb. 11, 1910. Serial. 1st part. No. 11854 A.

More Data as to the Water Supply for the Panama Canal and the Seepage from Gatun Lake. Information from the discussions of this subject by Col. H. F. Hodges, and C. M. Seville, giving authoritative data relative to the future water-supply. Maps. 5000 w. Eng News—Feb. 24, 1910. No. 11875.

*We supply copies of these articles. See page 158.*

**Piers.**

The Sewells Point Coal Pier, Virginian Railway. Illustrated description of a terminal for handling annually 4,500,000 tons of coal. 2500 w. Eng Rec—Feb 5, 1910. No. 11480.

The Reconstruction of the Tyne North Pier. Illustrated detailed description of this work. Plates. 5500 w. Engng—Jan. 28, 1910. No. 11536 A.

The Reconstruction of the Tyne North Pier. Illustrated detailed description of this interesting piece of engineering carried out at a cost of about £450,000. Plate. 4500 w. Engr, Lond—Jan. 28, 1910. No. 11542 A.

**River Regulation.**

River Regulation (Die Flussregulierung mittels Fangwerken). Max Jesovits. Describes a new system of construction of levees to prevent silting of channels recently tried in Austria. Ills. 3000 w. Oest Wochenschr f d Oeffent Baudienst—Jan. 29, 1910. No. 11903 D.

**San Francisco.**

The Harbor of San Francisco. Illustrated detailed description of the harbor on the Pacific coast. 4500 w. Marine Rev —Feb., 1910. No. 11567.

**Sea Walls.**

Some Types of Sea Walls and Their Structural Characteristics and Cost. George A. Orrock. Read before the Conn. Soc. of Engrs. Illustrates and describes constructions which have been used with success, stating some of the difficulties, and approximate costs. 1500 w. Engng-Con—Feb. 16, 1910. No. 11661.

**Switzerland.**

The Restoration of Inland Navigation in Switzerland (Herstellung von Schiffahrtsstrassen in der Schweiz). Viktor Pirner. A review of recent developments. Ills. 3000 w. Oest Wochenschr f d Oeffentlich Baudienst—Jan. 8, 1910. No. 11900 D.

**U. S. Waterways.**

Preliminary Report of the United States National Waterways Commission. Full report given as an answer to the question, "Will waterways pay?" 15500 w. Eng News—Feb. 3, 1910. No. 11413.

The Improvement of American Waterways and Harbors. Gives the recommendations of the United States National Waterways Commission. 10000 w. Eng Rec—Feb. 12, 1910. No. 11587.

Some Practical Views as to Transportation on Western Rivers. Thomas P. Roberts. Discusses the reasons for the decline in the river traffic, transportation on the Ohio, cost, etc. Ills. 4000 w. Eng News—Feb. 17, 1910. No. 11644.

Traffic on the Ohio River. John Howe Peyton. Extracts from the author's book on "The American Transportation Problem." Also editorial. 6500 w. Eng News —Feb. 17, 1910. No. 11645.

**Water Powers.**

State Conservation of New York Water Powers. Information from the report of the State Water Supply Commission in regard to the projects, policy recommended, etc. 2500 w. Eng Rec—Feb. 5, 1910. No. 11481.

### MISCELLANY.

**Construction Camps.**

Construction Camps in Great Britain. Gives recommendations from a recent report by Dr. Reginald Farrar to the Local Government Board. 2500 w. Eng Rec—Feb. 19, 1910. No. 11684.

## ELECTRICAL ENGINEERING.

### COMMUNICATION.

**Radio-Telegraphy.**

New Transmission Processes Employed in Wireless Telegraphy (Sur les nouveaux Procédés de Transmission employés en Télégraphie sans Fil). M. Ferrié. A review of progress in the development of methods for preventing interference of waves in the transmission of wireless messages. Ills. 8800 w. Bul Soc Int d'Elecns —Jan., 1910. No. 11705 F.

**Submarine Cables.**

Submarine Telephone Circuits Across San Francisco Bay. Samuel G. M'Meen. Illustrated description of the cable laid between San Francisco and Oakland to connect the automatic telephone systems. 1000 w. Elec Rev, N Y—Feb. 19, 1910. No. 11693.

**Telegraphy.**

Lord Kelvin and Telegraphy. Prof. J. A. Ewing. Abstract of second Kelvin lecture before the Inst. of Elec. Engrs. Reviews his work in submarine telegraphy. 5000 w. Elec Engr, Lond—Feb. 4, 1910. No. 11601 A.

The Work of Lord Kelvin in Telegraphy and Navigation. Prof. J. A. Ewing. (Abstract of second Kelvin lecture.) Deals especially with his work in telegraphy and in navigation. 3500 w. Elect'n, Lond—Jan. 21, 1910. No. 11376 A.

**Telephony.**

Condenser Telephones. C. Karl Ort and Josef Rieger. Trans. and abbreviated from the "E. T. Z." Illustrated description and report of tests. 1000 w. Elect'n, Lond—Jan. 21, 1910. No. 11373 A.

*We supply copies of these articles. See page 158.*

A Modern Automatic Telephone Apparatus. W. Lee Campbell. An illustrated description of the apparatus used and its method of operation in modern plants. 7500 w. Pro Am Inst of Elec Engrs—Feb., 1910. No. 11969 F.

The Automatic Electric Company's Telephone System. An explanation of the system, its scheme of connections, details of connectors and electors, etc. Ills. 5000 w. Engng—Feb. 11, 1910. Serial. 1st part. No. 11853 A.

See also Submarine Cables, and Telephotography, under COMMUNICATION.

**Telephotography.**

The Sémat Automatic Copier (Téléautocopiste Sémat); Loud-Speaking Telephones (Téléphones Haut-parleurs). F. Ducretet and E. Roger. Brief descriptions of the Sémat telautographic device and the Gaillard-Ducretet loud-speaking telephone. Ills. 1100 w. Soc Belge d'Elecns—Jan., 1910. No. 11701 E.

**Time Signals.**

See Electric Clocks, under MISCELLANY.

## DISTRIBUTION.

**Wiring.**

Wiring Formulae. R. W. Krass. Gives formulae found convenient in determining the size of copper conductors, volts loss in lines, current per wire, and weight of copper per circuit for any system of electrical distribution. 800 w. Sib Jour of Engng—Feb., 1910. No. 12003 C.

## DYNAMOS AND MOTORS.

**A. C. Dynamos.**

Oerlikon Turbo-Generators and Alternators. A. P. Chalkley. Illustration and description. 1500 w. Elect'n, Lond—Jan. 21, 1910. No. 11375 A.

Discussion on MM. Dalémont and Herdt's Paper on the Compounding of Alternators (Discussion de la Communication de MM. Dalémont et Herdt sur le Compoundage des Alternateurs). M. Blondel. Ills. 5000 w. Bul Soc Int d Elecns—Jan., 1910. No. 11706 F.

Eddy-Current Losses in the Copper Conductors of A. C. Armatures (Ueber die Wirbelstromverluste im Leitungskupfer der Wechselstromarmaturen). F. Rusch. Mathematical. Ills. Serial. 1st part. 2500 w. Elektrotech u Maschinenbau—Jan. 23, 1910. No. 11923 D.

Voltage Drop in Polyphase Synchronous Generators (Over den Spanningsafval bij meerphasige Synchronemachines). J. A. Schouten. Mathematical. Ills. 9000 w. De Ingenieur—Jan. 8, 1910. No. 11950 D.

See also Induction Generators, under DYNAMOS AND MOTORS.

**A. C. Motors.**

Single-Phase Commutator Motors and Their Industrial Applications (Moteurs monophasés à Collecteur et leurs Applications industrielles). Félix Roubaud. A discussion of the underlying principles of single-phase motors and of the work to which they are adapted. Ills. 3300 w. Tech Mod—Jan., 1910. No. 11714 D.

The Calculation of Leakage Losses in Three-Phase Motors (Die Berechnung der Stirnstreuung in Drehstrommotoren). Max Kloss. Mathematical. Ills. 3500 w. Elektrotech u Maschinenbau—Jan. 16, 1910. No. 11921 D.

**Armatures.**

Determination of the Moment of Inertia of a Continuous Current Armature. Dr. Gisbert Kapp. Read before the Inst. of Elec. Engrs. Explains the brake method and the flywheel method, and also a new electrical method, which has great advantages in the case of large machines. 2000 w. Elec Engr, Lond—Jan. 21, 1910. No. 11364 A.

**Commutation.**

The Present Position of the Theory of Commutation. J. Sumec. Abstract of lecture delivered before the Elektrotechnischer Verein. Shows that with straight line commutation the armature field outside the commutating zone is constant, while inside it varies slightly. Calculates the e. m. f. induced in the short-circuited coils for straight-line commutation and shows the application of formulae deduced. 2000 w. Elect'n, Lond—Feb. 11, 1910. No. 11833 A.

**D. C. Generators.**

The Additional Loss in D. C. Machines. J. F. H. Douglas. Abstract of a test showing the additional loss due to unequal flux-distribution under load. Ills. 1200 w. Sib Jour of Engng—Jan., 1910. No. 11964 C.

**Heating.**

Heating and Heat Transmission in Electrical Machines and Apparatus (Warmte en Warmteafvoer in electrische Machines en Apparaten). W. Lulofs. Mathematical. Ills. 7700 w. De Ingenieur Jan. 1, 1910. No. 11949 D.

**Induction Generators.**

The Induction Generator. Thomas Spooner and A. J. Barnes. A discussion of its operation in parallel with synchronous apparatus. Ills. 1000 w. Elec Wld—Feb. 24, 1910. No. 11960.

**Induction Motors.**

Relation Between the Stator and Rotor Circuits of the Single-Phase Induction Motor. Charles F. Smith. Aims to make clear the connection between the current and voltage in the stator of a single-phase induction motor and the current and voltage in the rotor. 5000 w. Elec Engr, Lond—Jan. 28, 1910. No. 11526 A.

The Requirements for an Induction Motor from the User's Point of View. Walter B. Nye. Discusses how to secure con-

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tinuity of operation and ease of repair. 1000 w. Pro Am Inst of Elec Engrs—Feb., 1910. No. 11974 F.

**Synchronous Condensers.**

Economics of Synchronous Condensers. B. F. Jakobsen. Discusses the monetary value of the overexcited synchronous motor in power transmission. 1700 w. Elec Wld—Feb. 10, 1910. No. 11513.

**Turbo-Dynamos.**

See Turbines, under MECHANICAL ENGINEERING, STEAM ENGINEERING.

## ELECTRO-CHEMISTRY.

**Electrochemistry.**

The Beginning of Electrochemistry. Saul Dushman. Reviews the early work of Galvani, and of Volta and the investigations following. Ills. 3500 w. Ap Sci—Feb., 1910. No. 12013 C.

**Electrolysis.**

The Electrolysis of Fused Metallic Materials (Schmelzflusselektrolyse). Dr. Arndt. A review of the applications of electrolysis in the extraction of refractory metals. 5500 w. Zeitschr d Ver Deutscher Ing—Jan. 15, 1910. No. 11941 D.

**Electrometallurgy.**

See Electrolysis, under ELECTRO-CHEMISTRY.

**Electroplating.**

Electrodeposition of Metals. Frederick Mollwo Perkin and William Earl Hughes. Read before the Faraday Soc. A short account of experiments made to ascertain the most efficient form of apparatus for the electrodeposition of metals. Describes the apparatus and its use. 1500 w. Elec Engr, Lond—Jan. 21, 1910. No. 11365 A.

The Future of Electroplating from the Electrochemists' View. Percy S. Brown. Address at meeting of Nat. Electroplaters' Assn. Remarks on the benefits of a knowledge of chemistry to the plater. 1200 w. Brass Wld—Feb., 1910. No. 11821.

Notes on Some Useful Chemical Apparatus That Can Be Employed in the Plating Room With Good Results. Illustrated descriptions. 2500 w. Brass Wld—Jan., 1910. No. 11677.

The Use of Lacquers. W. A. Jones. Address at meeting of the Nat. Electroplaters' Assn. Remarks on progress in metal work, especially in finish, color, and lacquer work. 2000 w. Brass Wld—Feb., 1910. No. 11822.

An Improved Method of Electroplating. Augustus Rosenberg. Description of the Galvanic electroplating process. Also discussion. 8500 w. Jour Soc of Arts—Feb. 4, 1910. No. 11592 A.

Modern Stereotypy, and the Mechanics of the Newspaper. Henry A. Wise Wood. Reviews the growth of the art, describing in detail how the problems encountered have evolved the modern autoplate process. Ills. 11600 w. Jour Fr Inst—Feb., 1910. No. 12016 D.

The Autoplate Machine. Report of the Franklin Institute, through its Committee on Science and the Arts, on the autoplate, a mechanism for producing stereotype plates. Ills. 2000 w. Jour Fr Inst—Feb., 1910. No. 12017 D.

**Nitrates.**

The Manufacture of Nitrates by the Process of the Salpetersaure-Industrie Gesellschaft (La Fabrication des Nitrates par le Procédé de la Salpetersaure-Industrie Gesellschaft). H. Marchand. Describes the Pauling system for the fixation of atmospheric nitrogen. Ills. 2200 w. L'Elecn—Jan. 8, 1909. No. 11722 D.

**Turpentine.**

The Electrical Distillation of Turpentine. O. Higman, Jr. Describes a process which makes economic use of waste matter at saw-mills. The invention of F. T. Snyder. Ills. 1000 w. Elec Wld—Feb. 17, 1910. No. 11642.

## ELECTRO-PHYSICS.

**Current Rectifiers.**

Crystal Rectifiers for Electric Currents and Electric Oscillations (Iron Pyrites). G. W. Pierce. Abstract of an article in the *Phys. Rev.* Gives a curve showing the rectifying action of iron pyrites, and compares the results with those obtained with molybdenite. 1200 w. Elect'n, Lond—Feb. 11, 1910. No. 11836 A.

**Electrons.**

The Experimental Basis of the Electron Theory (Le Basi Sperimentali della Teoria degli Elettroni). U. Bordoni. An exhaustive presentation of the electron theory and its development. Ills. Serial. 1st part. 5300 w. Ann d Soc d Ing e d Arch Ital—Jan. 1, 1910. No. 11740 F.

**Magnetic Properties.**

The Magnetic and Electrical Properties of the Iron-Copper Alloys. Charles F. Burgess and James Aston. Supplementary to an earlier paper. Reports tests made of the iron-copper alloys for magnetization and electrical conductivity. 1200 w. Met & Chem Engng—Feb., 1910. No. 11429 C.

**Magnetism.**

Mechanical Forces on a Conductor in a Magnetic Field (Die mechanischen Kräfte auf leitende Körper in elektrischen Feld). Fritz Emde. Mathematical discussion. Ills. 4000 w. Elektrotech u Maschinenbau—Jan. 9, 1910. No. 11920 D.

**Oscillations.**

Vibrators and Receivers for Short Electric Waves. H.W. Webb and L. E. Woodman. Abstract from *Phys. Rev.* Describes investigations to find relations between the dimensions and properties of vibrators and receivers used in measurements with short electric waves. 2500 w. Elect'n, Lond—Feb. 4, 1910. No. 11602 A.

On the Measurement of Wave Length for High Frequency Electrical Oscilla-

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tions. Albert Campbell. Abstract of a paper read before the Phys. Soc. Report of experimental investigations of wave meters. 1000 w. Elect'n, Lond—Jan. 21, 1910. No. 11377 A.

## GENERATING STATIONS.

**Accumulators.**

The Tate Bifunctional Accumulator Plate. Illustrated description of this unit and explanation of its operation. 4000 w. Can Engr—Jan. 28, 1910. No. 11339.

The Application of Accumulators in Direct- and Alternating-Current Plants (Anwendung von Akkumulatoren in Gleichstrom- und Drehstromzentralen). Richard Werkner. A discussion of their utility in taking care of the peak load. Ills. Serial. 1st part. 3700 w. Elektrotech u Maschinenbau—Jan. 30, 1910. No. 11925 D.

**Boosters.**

Boosters and Their Use in Street Railway Operation. L. S. O'Dell. Considers types of boosters and systems of control. Ills. 3500 w. Ap Sci—Jan., 1910. No. 11827 C.

**Central Stations.**

The Problem of the Peak in Generating Stations and the Use of Thermic Accumulators (Le Problème de la Pointe dans les Usines génératrices et l'Emploi des Accumulateurs thermiques). J. Izart. A discussion of the practical value of the Halpin thermic accumulator in central-station practice. Ills. Serial. 1st part. 3000 w. L'Elecn—Jan. 8, 1910. No. 11723 D.

Generating Station of the Sayre Electric Company. Illustrates and describes an application of the exhaust steam turbine in a small plant supplying a mixed railway and lighting service. 2500 w. Elec Wld—Feb. 3, 1910. No. 11463.

Castelnuovo-Valdarno Transmission Plant. Illustrated description of an Italian generating station located at lignite mines and transmitting energy to five cities. 2000 w. Elec Wld—Feb. 10, 1910. No. 11511.

The New Berlin-Rummelsburg Power Plant. Frank Koester. Illustrated description of an interesting new installation in Europe. 1800 w. Elec Rev, N Y—Feb. 12, 1910. No. 11573.

**Economics.**

Industrial Engineering by the Central Station. Discusses the developing of central station power business. 8000 w. Elec Jour—Feb., 1910. No. 12000.

The Supply of Electrical Power for Industrial Establishments from Central Stations. R. S. Hale. Discusses the question of a very large station, supplying comparatively small plants. 3500 w. Pro Am Inst of Elec Engrs—Feb., 1910. No. 11972 F.

Ice Making and Refrigeration by Central Stations. Newton Harrison. Discusses the use of power for this service during the period of light load. 2500 w. Cent-Sta—Feb., 1910. No. 11569.

Equitable Charges for Tramway Supply. H. E. Yerbury. Discusses "fixed charges" and "running costs" and presents a scheme for the equitable apportionment of charges for energy supplied to a tramway department. 3000 w. Elect'n, Lond—Jan. 28, 1910. No. 11528.

**Hydro-Electric.**

Discussion on "Comments on the Development and Operation of Hydroelectric Plants." New York, December 16, 1909. Discussion of the paper of Henry L. Doherty. 37500 w. Pro Am Inst of Elec Engrs—Feb., 1910. No. 11968 F.

Water Requirements of Railway Hydro-Electric Plants (Die Betriebswassermenge für hydraulische Bahnkraftwerke). Artur Hruschka. Considers the effect of the type of turbine and the load-factor on the amount of water required. Ills. 1500 w. Zeitschr f d Gesamte Turbinenwesen—Jan. 10, 1910. No. 11782 D.

Some Engineering Features of the Hakone, Japan, Hydroelectric Plant. S. Motomura. Descriptive account. 1500 w. Elec Wld—Feb. 10, 1910. No. 11512.

Engelberg-Lucerne Transmission System. Francis M. Weldon. Illustrated description of a Swiss hydroelectric generating station operating under a high head and having an unusual pole line. 2000 w. Elec Wld—Feb. 17, 1910. No. 11641.

Water-Power Plants in Sweden and Norway (Wasserkraftanlagen in Schweden und Norwegen). Illustrated description of a number of the important hydroelectric plants. Serial. 1st part. 2000 w. Zeitschr f d Gesamte Turbinenwesen—Jan. 20, 1910. No. 11784 D.

Hydro-Electric Plants of the South-West of France (Les Installations hydro-électriques du Sud-Ouest de la France). P. Postel-Vinay. Exhaustive description of the power development and distribution systems. Ills. 11000 w. Mem Soc Ing Civ de France—Nov., 1909. No. 11703 G.

The Plants on the Toce and Devers of the Societa per Imprese elettriche Conti (Gli Impianti del Toce e del Devers della Societa per Imprese elettriche Conti). Illustrated description. Serial. 1st part. 3000 w. Industria—Jan. 2, 1910. No. 11743 D.

The Andelsbuch Hydro-Electric Plant (Das Elektrizitätswerk Andelsbuch im Bregenzer Wald). G. Narutowicz. Detailed description of an important German water-power plant. Ills. Serial. 1st part. 2200 w. Schweiz Bau—Jan. 1, 1910. No. 11776 B.

The Mürzzuschlag Electrical Plant (Das märktische Elektrizitätswerk Mürzzuschlag). Karl Thien. Describes an important light and power plant with steam

auxiliary. Ills. 3200 w. Elektrotech u Maschinenbau—Jan. 2, 1910. No. 11919 D.

See also Austria, under STREET AND ELECTRIC RAILWAYS.

**Isolated Plants.**

Electricity on an Illinois Farm. Illustrated description of a gas producer power plant with storage-battery auxiliary. 1800 w. Elec Wld—Feb. 3, 1910. No. 11465.

A Benzol Motor Lighting Plant (Eine Beleuchtungsanlage durch Benzoldynamos). Max Arbeiter. Brief description of a hotel plant in the Alps. Ills. 1500 w. Elektrotech u Maschinenbau—Jan. 23, 1910. No. 11924 D.

**Rates.**

Rates for Hydroelectric Service. Alton D. Adams. Discussion of the conditions determining the rates offered by ten transmission companies. 1800 w. Elec Wld—Feb. 10, 1910. No. 11514.

**Signal Systems.**

Power Plant Signaling System. Warren O. Rogers. Illustrated description of a signaling system between switchboard operator and engineer, consisting of whistle, illuminated signal board and order panel. 1500 w. Power—Feb. 1, 1910. No. 11340.

**Switchboards.**

Distant Control Switchgear. Stephen Q. Hayes. An illustrated article considering recent improvements in switchboards, apparatus, and layouts; their reliability, economy in space and time, etc. 5000 w. Elec Age—Jan., 1910. Serial. 1st part. No. 11307.

**Valuation.**

Electrical Undertakings and the Law of Rating. The first part discusses the rating of electric lighting and power companies. 2500 w. Elec Rev, Lond—Jan. 21, 1910. Serial. 1st part. No. 11367 A.

## LIGHTING.

**Arc Lamps.**

Modern Arc Lamps and Their Application. A. Angold. Abstract of paper before the Assn. of Engrs-in-Charge. Considers the peculiarities of the arc stream and methods of attaining a steady arc, and describes types of arc lamps and matters related. 3000 w. Elect'n, Lond—Feb. 11, 1910. No. 11837 A.

A New Arc Lamp. P. A. Mossay. An account of a new arc lamp characterized by extreme simplicity. Ills. 2500 w. Elect'n, Lond—Feb. 11, 1910. No. 11834 A.

**Incandescent Lamps.**

Tests of Tungsten Lamps. T. H. Amrine and A. Guell. Describes a study of three types of tungsten lamps, differing in methods of manufacture and in scheme of mounting the filaments, with report of tests. Ills. 4000 w. Univ of Ill, Bul. No. 33—March 29, 1909. No. 11810 N.

New Incandescent Lamp Ratings. G. S. Merrill. Gives figures showing how the cost varies with the type of lamp, and the small cost of renewals. 1600 w. Cent. Sta—Feb., 1910. No. 11568.

**Photometry.**

The Flicker Photometer. J. S. Dow. A comparison of its performance with that of an "equality of brightness" type in color photometry. 4500 w. Elec Wld—Feb. 24, 1910. No. 11961.

The Physiological Principles Underlying the Flicker Photometer. J. S. Dow. Abstract of a paper read before the Phys. Soc. Describes experiments showing that the "Purkinje" and "yellow-spot" phenomena are less marked when using a flicker photometer. 3500 w. Elect'n, Lond—Jan. 21, 1910. No. 11372 A.

Heterochromatic Photometry. David Edgar Rice. An investigation of the subject based upon flicker photometric determinations. Ills. 2000 w. Elec Wld—Feb. 24, 1910. No. 11962.

**Street.**

Factors That Should Be Considered in Making Street Lighting Contracts. Discusses factors for which due allowance should be made. 1800 w. Cent Sta—Feb., 1910. No. 11570.

Queensboro Bridge Illumination. Illustrated account of the method of lighting the new cantilever across the East River at New York, and Blackwells Island, over which it passes. 2000 w. Elec Wld—Feb. 3, 1910. No. 11464.

The Proper Height for Street Lights (Die günstigste Höhe von Strassenlampen). J. Sumec. Discusses the height at which street lamps should be placed to secure most efficient illumination. Ills. 2400 w. Elektrotech u Maschinenbau—Jan. 2, 1910. No. 11917 D.

## MEASUREMENT.

**Dynamo Testing.**

The Testing of Electrical Machinery. R. F. Blackmore and V. W. Newman. Abstract of paper before the Manchester Sec. of the Inst. of Elec. Engrs. Considers the testing of small and large D. C. machines, A. C. machines, small and large induction motors, and alternators. 3000 w. Elec Rev, Lond—Jan. 21, 1910. No. 11368 A.

Tests of Turbine Alternators. Howard M. Nichols. Describes the tests to which alternating-current generators are subjected before being shipped. 3500 w. Elec Wld—Feb. 3, 1910. No. 11466.

**Galvanometer Scales.**

The Calculator-Board as a Calibrator of the Rymer-Jones Direct-Reading D. R. Galvanometer Scale. E. Raymond-Barker. Note for submarine cable staffs. 900 w. Elec Rev, Lond—Jan. 21, 1910. No. 11370 A.

**Resistance.**

The Measurement of the High-Frequency Resistance of Metallic Wires. Dr.

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J. A. Fleming. Gives results of some careful measurements on the high-frequency resistance of wires. 700 w. Elect'n, Lond—Feb. 11, 1910. No. 11835 A.

**Rubber Testing.**

The Testing of Rubber for Electrical Work. Prof. A. Schwartz. Abstract of paper read before the Manchester Sec. of the Inst. of Elec. Engrs. Describes a machine designed for testing rubber by hysteresis methods and discusses types of grip for holding the specimen. Ills. 3500 w. Elect'n, Lond—Jan. 21, 1910. Serial. 1st part. No. 11371 A.

The Testing of Rubber for Electrical Work. Editorial on the paper by Prof. A. Schwartz, before Inst. of Elec. Engrs., giving an account of a series of tests of tension and the determination of the hysteresis loop for various specimens under various conditions. 2000 w. Engng—Feb. 11, 1910. No. 11858 A.

Chemical and Mechanical Tests of Rubber (Prove chimiche e meccaniche del Caoutchouc lavorato). Carlo Parvopassu. A review of methods of testing rubber for electrical purposes. Ills. Serial. 1st part. 4000 w. Ann d Soc d Ing e d Arch Ital—Jan. 1, 1910. No. 11741 F.

**Wave Lengths.**

See Oscillations, under ELECTRO-PHYSICS.

## POWER APPLICATION.

**Heating.**

Induction Apparatus for Converting Electrical Energy into Heat, with Special Application to the Heating of Liquids (Apparecchio ad Induzione per Convertire industrialmente in Calore l'Energia elettrica anche ad alto Potenziale, con speciale Applicazione al Riscaldamento dei Liquidi). Alfredo Ponzini. Illustrated description. 1500 w. Industria—Jan. 30, 1910. No. 11744 D.

**Motor Boats.**

See same title, under MARINE AND NAVAL ENGINEERING.

## TRANSMISSION.

**Cables.**

Electric Cables. F. Fernie. The present number discusses paper-insulated lead-sheathed cables, the materials used, etc. Ills. 2500 w. Elect'n, Lond—Jan. 21, 1910. Serial. 1st part. No. 11374 A.

**Direct Current.**

Direct Current High Tension Transmission. A review of the direct current high tension situation showing its advantages in certain cases. Ills. 2500 w. Can Elec News—Feb., 1910. No. 11355 C.

**Lightning Protection.**

Lightning Conductors. Alfred Hands. Reviews the history of their use, discussing views of Sir Oliver Lodge and the report of the Lightning Research Committee. 7000 w. Elec Engr, Lond—Feb. 11, 1910. Serial, 1st part. No. 11830.

**Line Design.**

The Calculation of Transmission Lines. J. E. Dalemont. A review of various methods, with bibliography. 700 w. Can Elec News—Feb., 1910. Serial. 1st part. No. 11354 C.

Influences due to Extremely High Tensions in the Calculation of Transmission Lines (Influences dues aux très hautes Tensions dans le Calcul des Lignes). A. R. Garnier. Mathematical discussion of some of the phenomena introduced by high tensions. Ills. 2500 w. L'Elecn—Jan. 15, 1910. No. 11724 D.

**Lines.**

Ontario Government Transmission System. P. W. Sothman. A description, without technical terms, of the different phases of the work. Ills. 2000 w. Can Elec News—Feb., 1910. No. 11356 C.

See also Hydro-Electric, under GENERATING STATIONS.

**Losses.**

Losses Off Transmission Lines Due to Brush Discharge, With Special Reference to the Case of Direct Current. E. A. Watson. Discusses previous work upon the subject of the corona, describing experiments upon the loss from wires under direct-current pressures. Ills. 6500 w. Inst of Elec Engrs—Feb. 10, 1910. No. 11832 N.

**Polycyclic Currents.**

Electrical Transmission by Polycyclic Currents. Charles F. Smith. Gives an explanation of the methods proposed for effecting an economy in transmission by the use of polycyclic currents. 3500 w. Mech Engr—Feb. 4, 1910. Serial. 1st part. No. 11607 A.

**Regulations.**

Legislation on the Distribution of Electrical Energy (Législation sur les Distributions d'Energie électrique). A general discussion of the economic aspects of electric-power supply in Belgium. 6500 w. Soc Belge d'Elecns—Jan., 1910. No. 11700 E.

**Substations.**

New Substations in Chicago. Illustrated account of isolated and combination stations of the Commonwealth Edison Co. 2000 w. Elec Wld—Feb. 24, 1910. No. 11897.

**Transformers.**

The Design of Constant-Potential Transformers. W. T. Ryan. The present number gives an illustrated review of the development of the transformer. 1500 w. Elec Rev, N Y—Feb. 5, 1910. Serial. 1st part. No. 11472.

Current Transformers. P. C. Morganthaler. Paper presented at the Fort Wayne Section. Considers the application of the current transformer to, and its effect upon, electrical measuring instruments. 2200 w. Pro Am Inst of Elec Engrs—Feb., 1910. No. 11967 F.

*We supply copies of these articles. See page 158.*

### MISCELLANY.

**Electric Clocks.**

Electric Clocks (Notes sur l'Horlogerie électrique). Léopold Reverchon. Describes various systems for the transmission of time signals. Ills. Serial. 1st part. 1700 w. L'Elecn—Jan. 29, 1910. No. 11725 D.

**Germany.**

The Development and Position of the Electrical Industry of Germany (Die volkswirtschaftliche Entwicklung und Lage der deutschen elektrotechnischen Industrie). Dr. Bürner. A general review. 5800 w. Zeitschr d Ver Deutscher Ing—Jan. 29, 1910. No. 11948 D.

**Government Specifications.**

Government Specifications for Electrical Apparatus. Charles F. Scott. Discusses their relation to the standardization code of the American Institute of Electrical Engineers and to manufacturers. 5500 w. Elec Jour—Feb., 1910. No. 12001.

**Magnet Steel.**

Permanent Magnets and Magnet Steel. Translated from *Stahl und Eisen*. Gives results of extended experiments on the retentivity of different steels. 1500 w. Ir Trd Rev. Feb. 24, 1910. No. 11891.

**Rubber Gauntlets.**

The Manufacture and Testing of Rubber Gauntlets. J. Lustgarten. Concerning the manufacture and testing of special rubber gloves and gauntlets for handling live wires, etc. Ills. 2000 w. Elec Rev, Lond—Jan. 21, 1910. No. 11369 A.

## INDUSTRIAL ECONOMY.

**Accounting.**

A Technical Criticism of Balance Sheets (Technische Kritik von Industrie-Bilanzen). C. M. Lewin. Discusses inventories, misleading balance sheets, etc. Ills. 4500 w. Elektrotech u Maschinenbau—Jan. 16, 1910. No. 11922 D.

**Apprenticeship.**

Apprenticeship System of the Grand Trunk. An explanation of the system that has been in successful operation for a number of years. Ills. 2000 w. Ry Mas Mech—Feb., 1910. No. 11566.

**Cost Systems.**

Methods of Cost Analysis as Applied to Construction Work. DeWitt V. Moore. Read before the Am. Soc. of Engng. Contractors. Discusses the subject of properly recording costs, the methods as applied to labor costs, and as applied to material and expense. 5500 w. Engng-Con—Feb. 23, 1910. No. 11873.

Determining the Cost of Production in Manufacturing (Die Herstellungskosten-Berechnung in Fabrikbetrieben). C. Redtmann. A discussion of the general principles of cost keeping. Serial. 1st part. 1500 w. Elektrotech Rundschau—Jan. 12, 1910. No. 11911 D.

The Treatment of Time in Wage and Cost-Keeping Systems (Die Behandlung der Zeit in der Lohn- und Selbstkostenberechnung). W. Schneeloch. Discusses various methods of keeping and accounting for time. Ills. 4000 w. Tech u Wirt—Jan., 1910. No. 11931 D.

**Education.**

Education for Efficiency in Railroad Service. J. Shirley Eaton. A monograph on the educational preparation of young men for efficiency in railroad service. 60000 w. U. S. Bureau of Ed—Bul.,1909, No. 10. No. 11809 N.

Recent Tendencies in Technical Education in America (Les Tendances nouvelles de l'Enseignement technique et professionel en Amérique). H. Marchand. A review and discussion of recently proposed systems. 4500 w. Rev Gen d Sci—Jan. 30, 1910. No. 11720 D.

**Employers' Liability.**

Employers' Liability Under the Labor Insurance Act (Ueber die Haftpflicht nach dem Gewerbe-Unfall-Versicherungsgesetze). G. Link. Discusses the German law of employers' liability. Serial. 1st part. 1500 w. Elektrotech Rundschau—Jan. 5, 1909. No. 11910 D.

**Engineering Libraries.**

Problems and Aims of Technical Libraries (Aufgaben und Ziele technischer Bibliotheken). H. Füchsel. Discusses the equipment and management of a satisfactory technical library. Ills. 2700 w. Tech u Wirt—Jan., 1910. No. 11930 D.

**Exhibitions.**

The Japan-British Exhibition. Count Hirokichi Mutsu. Information concerning the proposed display to be made by Japan at the exhibition in London in 1910. Discussion. 8500 w. Jour Soc of Arts—Jan. 21, 1910. No. 11358 A.

**Indexing Systems.**

The Referencing of Engineering Literature. A. L. Menzin. Suggestions for improving libraries. 2000 w. Eng Rec—Jan. 29, 1910. No. 11320.

**Labor.**

The Patronal System in Labor Employment in Germany (Le Placement des Ouvriers par les Patrons en Allemagne). Maurice Bellom. A description of methods of registering, placing, and employing workmen through organizations in the various industries. 3500 w. Génie Civil—Jan. 29, 1910. No. 11738 D.

*We supply copies of these articles. See page 158.*

**Management.**

Organization by Production Factors. A. Hamilton Church. This sixth article of the series discusses the nature and use of control accounts. 4500 w. Engineering Magazine—March, 1910. No. 11979 B.

Factory Organization. James Rider. Read before the Rugby Engng. Soc. Discusses some of the important considerations in factory organization. 5500 w. Elec Engr, Lond—Jan. 21, 1910. No. 11366 A.

Works Management and Shop Costs. E. C. Peck. A discussion of plant organization to obtain the highest efficiency at least cost. 3500 w. Foundry—Feb., 1910. No. 11337.

The Engineering Trades on the Pacific Coast. George W. Dickie. Reviews briefly the history of engineering progress, and the recent falling off in the mechanical engineering work, and suggests a remedy. 4000 w. Jour Assn of Engng Socs—Dec., 1909. No. 11963 C.

**Natural Resources.**

See Timber, under CIVIL ENGINEERING, MATERIALS OF CONSTRUCTION.

**Patents.**

Some Hardships of Patent Infringement. L. P. Alford. Deals with certain legal steps in protecting the rights to the invention. 2500 w. Am Mach—Vol. 33. No. 6. No. 11508.

Monopoly Patents Should Not Be Granted. H. Ward Leonard. Discusses where the present system in regard to United States patents fails, giving a few suggestions. 2000 w. Am Mach—Vol. 33. No. 7. No. 11638.

The Definition of an Invention (Die Definition des Erfindungsbegriffes). Josef Löwy. Discusses the concept of an invention. 2200 w. Zeitschr d Oest Ing u Arch Ver—Jan. 7, 1910. No. 11792 D.

A Project for the Reform of the Patent Law (Projet de Réforme de la Loi des Brevets). André Taillefer. A discussion of unsatisfactory features of the French patent regulations. Serial. 1st part. 2500 w. Tech Mod—Jan., 1910. No. 11719 D.

**Philippine Islands.**

The Natural Resources of the Philippine Islands. Monroe Woolley. A detailed account of the vast resources, with illustrations. 5500 w. Cassier's Mag—Feb., 1910. No. 11666 B.

**Stores Keeping.**

The Handling and Storing of Factory Stock. Illustrates and describes methods used by the United Shoe Machinery Company. 1000 w. Ir Age—Feb. 24, 1910. No. 11868.

**Time Keeping.**

See Cost Systems, under INDUSTRIAL ECONOMY.

**Wage Systems.**

Compensation of Workmen and Efficiency of Operation. H. L. Gantt. This second article of a series discusses the proper operation of a piece-work system. 5000 w. Engineering Magazine—March, 1910. No. 11975 B.

Relative Cost of Municipal Work Done by Day-Labor and Contract, in Boston, Mass. Harrison P. Eddy. Read before the Am. Assn. for the Adv. of Sci. Gives interesting results of investigations to determine the comparative cost and efficiency of the two systems. 4500 w. Eng News—Jan. 27, 1910. No. 11286.

Some Notes on Handling Men on Construction Work. Notes of experience brought out in a discussion on Halbert P. Gillette's paper on "Science of Management Engineering." 3500 w. Engng-Con—Jan. 26, 1910. No. 11292.

**Welfare Work.**

What More Than Wages? Kenneth Falconer. A review of welfare institutions, discussing conditions and the attitude of men and employers. Ills. 3500 w. Engineering Magazine—March, 1910. No. 11977 B.

Welfare Work on the Canadian Pacific Railway. Abstract of a pamphlet describing the work. 2500 w. Am Engr & R R Jour—Feb., 1910. No. 11488 C.

## MARINE AND NAVAL ENGINEERING.

**Electric Power.**

Electrical Transmission and Communication on Shipboard (Transmissions et Communications à Bord des Navires). Georges Dary. Discusses the various uses of electricity on shipboard, particularly in communication, and the general principles of transmission. 4400 w. L'Elecn—Jan. 1, 1909. No. 11721 D.

**Ferry Steamers**

The Train Ferry Steamers "Deutschland" and "Preussen" (Die Eisenbahnfährschiffe "Deutschland" und "Preussen"). W. Kaemmerer. Describes the train ferries built by the Vulcan Works, Stettin, for service between Germany and Sweden. Ills. 1800 w. Zeitschr d Ver Deutscher Ing—Jan. 1, 1910. No. 11932 D.

**Japanese Merchant Marine.**

Shipbuilding and Shipping in Japan. T. Good. Brief account of their rapid upbuilding under subsidy legislation. 2000 w. Ir Age—March 3, 1910. No. 12068.

*We supply copies of these articles. See page 158.*

**Lifeboats.**

The Lifeboat and Its Work. Sir John Cameron Lamb. An account of the work of the life-saving service, describing the development of the lifeboat. Discussion. 11500 w. Jour Soc of Arts. Feb. 18, 1910. No. 12046 A.

**Model Tests.**

A Consideration of Results of Tests on Ships' Models (Betractung zu Resultaten von Modell-Schleppversuchen). Jul. Ott. Gives results of tests on a model of a freight and passenger steamship. Ills. Serial. 1st part. 6500 w. Schiffbau—Jan. 12, 1910. No. 11770 D.

**Motor Boats.**

The 1910 National Motor Boat Show. A description of exhibits, with illustrations, and general remarks on the industry. 17000 w. Naut Gaz—Feb. 24, 1910. No. 11866.

Accumulator Boats (Akkumulatoren-Boote). R. Deetjen. Discusses their design, describes equipment, gives results of operation, etc. Ills. Serial. 1st part. 4000 w. Schiffbau—Jan. 12, 1910. No. 11771 D.

**Propellers.**

Two, Three, or Four Propellers? A discussion of the advantages and disadvantages of the three types, concluding that twin screws still hold the field under stated conditions. 4000 w. Engr, Lond—Feb. 4, 1910. No. 11620 A.

A Synthetic Treatment of Propeller Theory (Teoria sintetica dell' Elica propulsatrice). G. Rabbeno. Mathematical. Ills. 8500 w. Riv Marit—Jan., 1910. No. 11739 E + F.

**Shipbuilding.**

See Dock Machinery, under ELECTRICAL ENGINEERING, POWER APPLICATIONS.

**Ship Deformation.**

The Elastic Deformation of Ships (Elastische Formänderung des Schiffskörpers). R. Siemann. Discusses methods of measurement and calculation and gives results of investigations on various vessels. Ills. Serial. 1st part. 4000 w. Schiffbau—Jan. 26, 1910. No. 11772 D.

**Steamboats.**

The Pioneer Inventors of the Steamboat. Reviews the events in the development of the steamboat, aside from Fulton's work, as an argument that the proposed "water gate" to be erected on the Hudson River, at 110th St., New York City, should commemorate a historical group and not Fulton only. 4500 w. Eng News—Feb. 24, 1910. No. 11880.

The Development of Steam Navigation on the Great Lakes. James Cooke Mills. Illustrates and describes early steamboats used on Lakes Erie and Ontario, giving 15 illustrations. 4000 w. Cassier's Mag—Feb., 1910. No. 11670 B.

**Steamships.**

The New Castle Liner Balmoral Castle. Illustrated description of the new 13000-ton Union-Castle mail liner, recently launched. 2000 w. Int Marine Engng—Feb., 1910. No. 11498 C.

S. S. Herman Frasch. Illustrated description of a single screw steamship of the single-deck type. 1500 w. Int Marine Engng—Feb., 1910. No. 11500 C.

New Steamers for the Nippon Yusen Kaisha. Drawings, photographs and description of four new twin-screw steamers built in Japan. 3300 w. Engng—Feb. 4, 1910. Serial. 1st part. No. 11615 A.

The New Steamship of the "Zeeland" Navigation Company (Eenige gegevens betreffende de nieuwe Stoomschepen der Stoomvaart-Maatschappij "Zeeland," Koninklijke Nederlandsche Postvaart). Th. H. de Meester. Describes the new "Prinses Juliana." Ills. 5000 w. De Ingenieur—Jan. 15, 1910. No. 11951 D.

**Steam Turbines.**

The Westinghouse Marine Steam Turbine. Illustrated description of a new design particularly adaptable for use in connection with the Melville-Macalpine reducing gear for marine propulsion. 2000 w. Ir Age—Feb. 17, 1910. No. 11630.

American Marine Turbines and Gearing. Illustrates and describes the Westinghouse turbine and the Melville and Macalpine speed-reduction gear. 4500 w. Engr, Lond—Feb. 18, 1910. No. 12067 A.

The Main Turbines of H. M. S. Collingwood. Illustrates these turbines of the Parsons type, and gives particulars of the vessel. 2 plates. 700 w. Engr, Lond—Feb. 11, 1910. No. 11844 A.

Turbine Propulsion—Recent Developments. R. M. Neilson. Discusses certain recent developments and proposals relating to steam turbine propulsion. 7000 w. Int Marine Engng—Feb., 1910. No. 11499 C.

**Submarines.**

The First Submarine Boats for Austria-Hungary. Gives details of these vessels. 1700 w. Engr, Lond—Feb. 11, 1910. No. 11845 A.

Suggested Methods of Escape Out of a Sunken Submarine. George Frederick Zimmer. Illustrates and describes appliances for the safety of submarine crews. 2000 w. Cassier's Mag—Feb., 1910. No. 11669 B.

**U. S. Merchant Marine.**

American Shipping: Its Past, Present, and Future from a British Point of View. T. Good. Presents a British view of American marine development. 2200 w. Cassier's Mag—Feb., 1910. No. 11673 E.

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# MECHANICAL ENGINEERING.

## AUTOMOBILES.

**Accessories.**

Parts and Accessories at the New York Shows. Illustrates and describes the frames, clutches, etc., axles and bearings, springs, driving chains, radiators, carbureters, magnetos, etc. 10500 w. Com Veh —Feb., 1910. No. 11434 C.

**Agricultural Machinery.**

Power Cultivation of the Soil. E. W. Hamilton. Abstract of a paper read at meeting of the Am. Soc. of Agri. Engrs. A review of methods used in traction cultivation. 3300 w. Eng News—Feb. 10, 1910. No. 11523.

**Clutches.**

The Clutch Problem. Albert L. Clough. Considers the requirements of a good clutch, and examines the claims of various types. 2000 w. Automobile—Feb. 16, 1910. No. 11656.

**Commercial Vehicles.**

The Electric Commercial Vehicle at the Close of 1909. J. H. Vail. Illustrated review of recent types of vehicles, with general remarks. 1000 w. Elec Rev, N Y—Feb. 12, 1910. No. 11574.

Commercial Vehicles at the New York Shows. Discusses the characteristic features of the machines exhibited. Ills. 7500 w. Com Veh—Feb., 1910. No. 11433 C.

**Compressed-Air Transmission.**

Hautier Compressed-Air Transmission for Heavy Commercial Vehicles (Transmission à Air comprimé, Système Hautier, pour Véhicules industriels, Poids lourds). L. Pierre-Guédon. Describes the mechanism and discusses its efficiency. Ills. 2000 w. Génie Civil—Jan. 15, 1909. No. 11736 D.

**Construction.**

See Shop Practice, under MACHINE WORKS AND FOUNDRIES.

**Crank Cases.**

Some Points in Crank Case Design. Discusses briefly some of the general principles of crank case design. Ills. 1500 w. Horseless Age—Jan. 26, 1910. No. 11332.

**De Dion.**

Small Cars of 1910. The De Dion four-cylinder "Ten" is described as an example of the 66 M. M. class. Ills. 1500 w. Auto Jour—Jan. 22, 1910. No. 11361 A.

**Design.**

Sporting Two-Seaters. Eric W. Walford. Considers points of importance in the design of such cars. Ills. 2000 w. Autocar—Feb. 5, 1910. No. 11595 A.

The "Auto." Olympia Competition. The Ten Best Novelties in the Design and Construction of Motor Chassis, as Exhibited at Olympia, November 12 to 20, 1909. Bertram C. Joy. First prize essay awarded £50. Ills. 2500 w. Auto Jour Jan. 22, 1910. No. 11362 A.

The "Auto" Olympia Competition. The Ten Best Novelties in the Design and Construction of Motor Chassis as Exhibited at Olympia, November 12 to 20, 1909. Second prize essay. (Awarded £25.) Edward Butler. 3500 w. Auto Jour—Jan. 29, 1910. No. 11525 A.

**Electric Batteries.**

The Care and Handling of "National" Vehicle Batteries. A. H. Ackermann. Directions for unpacking, charging, discharging, cleaning, etc. 3500 w. Cent Sta—Feb., 1910. No. 11572.

**Electric Vehicles.**

The Performance of the Electric Vehicle in the Recent Blizzards. Frank J. Stone. Reports their very successful operation. 2000 w. Cent Sta—Feb., 1910. No. 11571.

See also Commercial Vehicles, under AUTOMOBILES.

**Garages.**

Some Vermont Garages. Illustrates and describes garages at Rutland, Burlington, White River Junction and other places. 2500 w. Horseless Age—Feb. 2, 1910. No. 11457.

**Gears.**

Remarks Relating to Gear and Pinion Failures. George Wm. Sargent. Read before the Soc. of Auto Engrs. Presents facts noticed by the author. 1000 w. Automobile—Feb. 10, 1910. No. 11551.

**Ignition.**

Magnetos and Auxiliary Ignition Systems. Illustrates and describes some of the appliances now used. 2200 w. Automobile—Feb. 3, 1910. No. 11468.

**Industry.**

The French Automobile Industry. A review of the conditions which caused the severe crisis in the industry, with a brief history of several French companies. 2500 w. Engng—Feb. 11, 1910. No. 11852 A.

**Motor Control.**

Foot Throttle versus Hand Throttle. Albert L. Clough. Discusses the advantages and disadvantages of the foot throttle. 1700 w. Horseless Age—Feb. 2, 1910. No. 11456.

**Motor Power.**

Relation of Power to Speed. Considers various sources of power losses. 1500 w. Automobile—Feb. 17, 1910. No. 11654.

**Motor Rating.**

Motor Ratings Discussed. Considers

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some methods of determining the power delivered by the motor. 1800 w. Automobile—Feb. 17, 1910. No. 11652.

**Motors.**

Concerning Sleeve-Valve Petrol Engines. Illustrates and describes details of a design by Messrs. C. E. Drummond and F. J. Bostock. 2000 w. Auto Jour—Feb. 5, 1910. No. 11594 A.

Preheating the Mixture in Gasoline Motors. Forrest R. Jones. Discusses the good and bad effects of the practice. 1800 w. Automobile—Feb. 10, 1910. No. 11550.

**Motor Testing.**

Dynamometer Methods Employed. Discusses methods of testing an automobile motor for power and efficiency. 1800 w. Automobile—Feb. 17, 1910. No. 11653.

**Motor Torque.**

Motor Torque at Low Rotating Speeds. Albert L. Clough. Discusses the attainment of low speed high torque qualities. 2500 w. Horseless Age—Jan. 26, 1910. No. 11333.

**Napier.**

The 15 h. p. Four-Cylinder Worm-Driven Napier. Illustrated description. 1400 w. Autocar—Feb. 5, 1910. No. 11596 A.

**Panhard.**

The 30 h. p. Six-Cylinder Panhard. Illustrated description. 1000 w. Autocar—Jan. 22, 1910. No. 11363 A.

**Springs.**

Laminated Springs for Motor Cars. Laurence H. Pomeroy. Discusses the problem of springing motor vehicles and the advantages of laminated springs. 2500 w. Autocar—Feb. 12, 1910. No. 11851 A.

**Tires.**

Tires, Rims, and Chains. Illustrates and describes some of the latest productions. 2000 w. Automobile—Feb. 3, 1910. No. 11467.

**Traction Engines.**

Special Types of Traction Engines. William Fletcher. Illustrates and describes steam traction engines for colonial service. 3000 w. Cassier's Mag—Feb., 1910. No. 11672 B.

Directions for Working Steam Road Rollers and Steam Traction Engines. Instructions from a booklet issued by an English firm relating to the preparations, management, care of engine, and precautions for safety. 4500 w. Engng-Con—Feb. 16, 1910. No. 11660.

**Vinot.**

Small Cars of 1910. Illustrated description of the Vinot "Twelve-Sixteen," as a type of the 80 mm. class. 1200 w. Auto Jour—Jan. 29, 1910. No. 11524 A.

## COMBUSTION MOTORS.

**Aeronautic Motors.**

Points in the Design of Aeronautic Motors. Eugen P. Batzell. States the important requirements, and discusses details. 4000 w. Horseless Age—Feb. 16, 1910. Serial. 1st part. No. 11655.

The Wolseley 60-Horse-Power Motor for Aeroplanes. Views and description of a motor of British make. 500 w. Engng—Feb. 4, 1910. No. 11618 A.

**Benzol Motors.**

See Isolated Plants, under ELECTRICAL ENGINEERING, GENERATING STATIONS.

**Fuels.**

Oil Gas for Power and Lighting. General discussion of the advantages of oil gas and brief illustrated description of a plant at Alford near Chester, England. 1700 w. Engr, Lond—Jan. 28, 1910. No. 11544 A.

**Gas-Engine Governing.**

The Governing of Large Two-Cycle Gas Engines (Regelungen von Zweitact-Gross-Gasmaschinen). Ernst Tuckermann. An exhaustive review of methods. Serial. 1st part. 2000 w. Elektrotech Rundschau—Jan. 19, 1910. No. 11913 D.

**Gas Engines.**

A New Six-Stroke for Internal Combustion Engine. M. L. King. Read before the Am. Soc. of Agri. Engrs. Describes a new internal combustion engine cycle, discussing its applications, conditions and advantages. 2500 w. Naut Gaz—Feb. 3, 1910. No. 11486.

**Gas Power Plants.**

Test Run of a Producer and Engine Plant. William O. Webber. Illustrated description of plant at the Soldiers' Home, Chelsea, Mass., with report of test. 500 w. Power—Feb. 8, 1910. No. 11497.

Increasing Use of Producer Gas Plants. A. S. Atkinson. Remarks on the fuels used, and the increasing applications. 2200 w. Ir Trd Rev—Feb. 3, 1910. No. 11437.

**Gas Producers.**

A Bituminous Power Gas Producer. E. F. Bulmahn. An illustrated article describing the classes of producers and their operation, giving results and industrial applications. General discussion. 4500 w. Pro Engrs' Soc of W Penn—Jan., 1910. No. 11966 D.

**Gas Turbines.**

The Present Status of the Gas Turbine (Etudie über die gegenwärtige Lage der Gasturbine). Marcel Armangaud. Reviews progress, and discusses mathematically the problem of the gas turbine. Ills. Serial. 1st part. 3000 w. Zeitschr f d Gesamte Turbinenwesen—Jan. 20, 1910. No. 11783 D.

**Indicator Diagrams.**

A Graphical Method of Translating the Indicator Diagram of a Combustion Motor Into the Entropy Diagram (Ein graphisches Verfahren zur Uebertragung der Indikatordiagramme von Verbrennungsmaschinen in das Entropiediagramm). V. Maleev. Mathematical dem-

onstration. Ills. 6000 w. Zeitschr d Oest Ing u Arch Ver—Jan. 14, 1910. No. 11795 D.

**Lubrication.**

See Engine Lubrication, under STEAM ENGINEERING.

**Oil Engines.**

Oil Engines for Agricultural Purposes. Editorial on the practical advantages of the oil engine and the neglect in applying it to agricultural work. 1600 w. Engng—Jan. 21, 1910. No. 11392 A.

Four-Cylinder Oil-Engine and Starting-Engine. Illustrates and describes the principal features of a crude oil engine of new type, built for the Great Indian Peninsular Ry. Co., Ltd. 1000 w. Engng—Jan. 28, 1910. No. 11538 A.

**Producer Gas.**

The Utilization of Gas for Lighting, Heating and Motive Power (Procédés actuels d'Eclairage, de Chauffage et de Force motrice par le Gaz). J. F. Andouin. A general review of the applications of producer gas. Ills. Serial. 1st part. 3000 w. Rev Indus—Jan. 8, 1910. No. 11729 D.

## HEATING AND COOLING.

**Air Purification.**

The Permanent Place of the Air Washer in Heating and Ventilating Work. From the report of the Committee on Air Washers, read at meeting of the Soc. of Heat. & Vent. Engrs. Considers types and their care and efficiency. 2000 w. Heat & Vent Mag—Feb., 1910. No. 12011.

**Cooling Towers.**

Cooling Towers. J. R. Bibbins's paper is discussed. 9800 w. Jour Am Soc of Mech Engrs—Feb., 1910. No. 11991 F.

**Refrigeration.**

See Economics, under ELECTRICAL ENGINEERING, GENERATING STATIONS.

**Ventilation.**

The Employment of Sheet-Metal Ducts in Mechanical Ventilation (L'Impiego di Canali in Lamiera nelle Installazioni di Ventilazione meccanica). C. A. Gullino. A note on their design. Ills. 3000 w. Monit Tech—Jan. 10, 1910. No. 11742 D.

## HYDRAULIC MACHINERY.

**Centrifugal Pumps.**

The Design, Construction and Operation of Centrifugal Pumps. Franz zur Nedden. The third part of a critical discussion dealing with structural features and manufacturing considerations. Ills. 2500 w. Engineering Magazine—March, 1910. No. 11981 B.

Tests of the Second Pumping Plant of the St. Gallen Water Works (Versuche an der Zweiten Pumpen-Anlage im Wasserwerk der Stadt St. Gallen). P. Ostertag. The plant consists of a high-lift centrifugal pump belt driven by a Diesel motor. Ills. Serial. 1st part. 1000 w. Schweiz Bau—Jan. 1, 1910. No. 11777 B.

**Gas Pump.**

The Humphrey Gas-Pumps. Editorial discussion with the object of showing the advantage of a short, as compared with a long, play-pipe. 2500 w. Engng—Feb. 11, 1910. No. 11857 A.

**Hydrodynamics.**

Some First Steps in the Science of Hydraulics. Ernest W. Schoder. Discusses methods of measuring the pressure head and velocity head of flowing water. Diagrams. 2000 w. Cornell Civ Engr—Feb., 1910. No. 12005 C.

**Penstocks.**

Steel Penstocks. R. A. Wright. Gives a general outline of the principles governing the design of steel penstocks, describing designs taken from actual installations. 4000 w. Eng News—Feb. 10, 1910. No. 11519.

**Pumping Engines.**

Recent Records of High-Duty Water-Works Pumping Engines. Gives results of duty tests at Albany, N. Y., and Milwaukee, Wis. Ills. 2500 w. Eng News—Feb. 3, 1910. No. 11410.

Combined Horizontal and Vertical Pumping Engines. Illustrates and describes a recent installation for Nottingham water supply, of two sets of combined horizontal and vertical Corliss triple-expansion deep-well and high-lift surface-condensing pumping engines. Plate. 1500 w. Engr, Lond—Feb. 4, 1910. No. 11623 A.

**Pumping Plants.**

Pumping Stations of the Minidoka Irrigation Project. Illustrates and describes the design and equipment of the pumping stations and uses made of the current from this hydroelectric development in Idaho, already described. 3000 w. Eng Rec—Feb. 19, 1910. No. 11678.

**Pumps.**

Artesian Well Pump. F. C. Weber. Illustrated description of new subterranean pump patented by the writer, explaining its operation, and comparing with other pumps. 3000 w. Ice & Refrig—Feb., 1910. No. 11445 C.

**Pump Valves.**

Pump Valves and Valve Areas. A. F. Nagle's paper on this subject is discussed generally. 3500 w. Jour Am Soc of Mech Engrs—Feb., 1910. No. 11992 F.

**Rams.**

Theory of the Hydraulic Ram (Theorie des hydraulischen Widders). H. Lorenz. Mathematical discussion. Ills. 2600 w. Zeitschr d Ver Deutscher Ing—Jan. 15, 1910. No. 11939 D.

**Turbine Governing.**

The Governing of Hydraulic Turbines (Neuerungen auf dem Gebiete des Regulatorenbaues für Wasserturbinen). Herr Euler. Describes recent types of gover-

*We supply copies of these articles. See page 158.*

nors. Ills. Serial. 1st part. 1500 w. Zeitschr f d Gesamte Turbinenwesen—Jan. 10, 1910. No. 11781 D.

**Turbine Plants.**

Designs for Hydraulic Power Plants Subject to Reduced Head During High Water. Brief illustrated description of Clemens Herschel's "fall increaser" to compensate for loss of head, and its application. 500 w. Eng News—Feb. 24, 1910. No. 11877.

**Turbines.**

The Type Characteristic of Impulse Wheels and Its Use in Design. S. J. Zowski. A mathematical investigation. 3500 w. Eng News—Feb. 10, 1910. No. 11518.

The Development of the Hydraulic Reaction Turbine in America. H. Birchard Taylor. An illustrated review of the progress in design and in avoiding erosion. 4000 w. Engineering Magazine—March, 1910. No. 11978 B.

Most Powerful Turbines Designed and Built. H. Birchard Taylor. Illustrated description of four 18000-h.p. hydraulic turbines recently installed at Oroville, Cal., representing the highest development of water-wheel design. 2500 w. Am Mach—Vol. 33. No. 7. No. 11635.

The Characteristics of the Francis Turbine (Ueber die Charakteristik der Francis-Turbine). Herr Kröner. Mathematical discussion. Ills. Serial. 1st part. 2000 w. Die Turbine—Jan. 5, 1910. No. 11779 D.

**Water Hammer.**

Water Hammer in Conduits (Coups de Bélier dans les Conduites). R. Neeser. Results of an experimental investigation and verification of Alliévis theories. Ills. Serial. 1st part. 2700 w. Bul Tech d l Suisse Rom—Jan. 10, 1910. No. 11728 D.

## MACHINE ELEMENTS AND DESIGN.

**Ball Bearings.**

Ball Bearings (Ueber Kugellager). August Bauschlicher. A review of the development of the ball-bearing industry, discussing materials, types, design, etc. Ills. Serial. 1st part. 3500 w. Stahl u Eisen—Jan. 26, 1910. No. 11755 D.

**Blows.**

What Is the Force of a Blow? S. B. Redfield. Explains method of calculating the force. 1200 w. Am Mach—Vol. 33. No. 5. No. 11419.

**Crane Hooks.**

The Design of Curved Machine Members Under Eccentric Load. Prof. Walter Rautenstrauch's paper is discussed. 7000 w. Jour Am Soc of Mech Engrs—Feb., 1910. No. 11989 F.

**Drafting Machines.**

The Simplon Combination Drafting-Machine. Illustrated description. 800 w. Engng—Jan. 21, 1910. No. 11389 A.

**Gears.**

Derivation of Bevel Gear Formulas. Ralph E. Flanders. Gives derivations of the formulae for calculating the dimensions of gearing for conditions of shaft angles and types of gears. Data sheet supplement. 1000 w. Mach, N Y—Feb., 1910. No. 11350 C.

The Melville and Macalpine Reduction Gear for Marine Steam Turbines. Ralph E. Flanders. Illustrated detailed description of the gear and its tests, with personal observations. 5000 w. Mach, N Y—Feb., 1910. No. 11344 C.

See also Steel, under MATERIALS OF CONSTRUCTION.

**Gyroscope.**

The Brennan Gyroscope. A. F. Dickinson. A simple illustrated explanation of this device. 1500 w. Cassier's Mag—Feb., 1910. No. 11667 B.

**Piston Rings.**

The Elasticity of Piston Rings (Elasticité des Cercles de Piston). Maurice Sainturat. Mathematical discussion of their design. Ills. 3500 w. All Indus—Jan., 1910. No. 11727 D.

**Springs.**

The Design of Spiral Springs for Safety Under Transverse Stress (Berechnung zylindrischer Druckfedern auf Sicherheit gegen seitliches Ausknicken). E. Hurlbrink. Mathematical discussion. Ills. Serial. 1st part. 4500 w. Zeitschr d Ver Deutscher Ing—Jan. 22, 1910. No. 11943 D.

**Stresses.**

Hoop or Ring Stress. Gives a chart for the determination of centrifugal tension in rims, belts, ropes, etc., explaining its use. 600 w. Prac Engr—Jan. 28, 1910. No. 11529 A.

## MACHINE WORKS AND FOUNDRIES.

**Boiler Making.**

See Shops, under MACHINE WORKS AND FOUNDRIES.

**Boring.**

See Machine Tools, under MACHINE WORKS AND FOUNDRIES.

**Brass Founding.**

Diagrams of Mixtures for the Brass Foundryman. J. F. Buchanan. Gives applications of the graphic method to foundry practice and calculations, showing the proportions in various alloys. 1500 w. Foundry—Feb., 1910. No. 11338.

**Chain Making.**

Making Chains by Hand and Machine. Methods used in making chains for hoists and for battleships' anchors are illustrated and described. 2000 w. Am Mach—Vol. 33. No. 8. No. 11896.

**Cleaning Baths.**

The Cleaning of Metal Work. S. D. Benoliel. Address before the Nat. Electroplaters' Assn. Considers cleaners generally used and their properties and lim-

itations. 3000 w. Brass Wld—Feb., 1910. No. 11823.

**Forging.**

Making Heavy Chain and Anchors for Uncle Sam. Chester L. Lucas. Illustrated description of the processes and machinery used in the Charlestown Navy Yard where the chains and anchors for the United States navy are made. 2000 w. Mach, N Y—Feb., 1910. No. 11347 C.

**Foundries.**

A Permanent Mold Gray Iron Foundry. Illustrated description of the Tacony Iron Co.'s sandless foundry, and the use of cast-iron molds and cores in the production of soil pipe fittings. 4500 w. Foundry—Feb., 1910. No. 11334.

A Sandless Iron Foundry. Illustrated detailed description of the permanent mold gray iron foundry of the Tacony Iron Co., Philadelphia. 5000 w. Ir Trd Rev—Feb. 10, 1910. No. 11552.

**Foundry Buildings.**

Foundry Buildings and Their Influence on Financial Returns (Giessereihallenbauten und ihre Rentabilität für den Betrieb). R. Lots. A discussion of the design, layout, and construction of foundry buildings. Ills. Serial. 1st part. 2400 w. Giesserei-Zeit—Jan. 1, 1910. No. 11769 D.

**Foundry Design.**

Foundry Plant and Machinery. Joseph Horner. This first article of a series considers the foundry buildings and their arrangements. 3000 w. Engng—Jan. 21, 1910. Serial. 1st part. No. 11385 A.

**Foundry Practice.**

The Production of Grate Bars (Ueber die Roststabgiesserei aus früherer und neuerer Zeit unter Berücksichtigung praktischer Erfahrungen und Ergebnisse). H. Vetter. A review of past and present practice. Ills. Serial. 1st part. Giesserei-Zeit—Jan. 1, 1910. No. 11767 D.

**Furnaces.**

Over-Fired and Under-Fired Heat Treating Furnaces. E. F. Lake. Illustrates and describes oil-burning furnaces and their equipment and management. 2500 w. Am Mach—Vol. 33. No. 5. No. 11421.

**Grinding.**

The Grinding Machine in Automobile Shops. H. Darbyshire. Illustrates and describes work on the cylinder grinder, machining, etc. 3500 w. Am Mach—Vol. 33. No. 5. No. 11420.

**Grinding Machines.**

The Operation of Emery Wheels (Betrieb von Schmirgelscheiben). A report on the conditions affecting the safety of emery wheels. 3000 w. Zeitschr f Werkzeug—Jan. 15, 1910. No. 11787 D.

**Grinding Wheels.**

The Manufacture of Grinding Wheels (Die Fabrikation der künstlichen Schleifscheiben). K. Voigt. Discusses materials, their preparation, and their manufacture into grinding wheels. 4200 w. Zeitschr d Ver Deutscher Ing—Jan. 15, 1910. No. 11940 D.

**Jigs.**

Jigs in a Repair Shop. A. H. Lavers. Illustrates a number of simple jigs for various operations; also some simple lathe and boring mill chucks. Descriptions. 2500 w. Mach, N Y—Feb., 1910. No. 11348 C.

**Machine Tools.**

Machine-Tools for Grinding, Boring, and Drilling. Illustrates and describes English designs. 1000 w. Engng—Feb. 11, 1910. No. 11855 A.

The Narrow Guide in Machine Tools. Fred Horner. Illustrates and describes its application to the design of sliding bearings of various kinds to prevent cramping. 1000 w. Am Mach—Vol. 33. No. 8. No. 11805.

Tool-Holder Designs. F. P. Crosby. Shows designs for turret-lathe and automatic screw machine work. 600 w. Mach, N Y—Feb., 1910. No. 11353 C.

Applications of the Electromagnet in the Machine Shop (Elektromagnetische Spannplatten). Hubert Hermanns. Describes the application of the electromagnet in holding work during machining. Ills. Serial. 1st part. 2200 w. Zeitschr f Werkzeug—Jan. 22, 1910. No. 11788 D.

Machine Tools for Mass Production (Werkzeugmaschinen für Zwecke der Massenfabrikation). Rudolf Langner. Describes various machines built by DeFries & Cie., Düsseldorf. Ills. 3000 w. Zeit d Oest Ing u Arch Ver—Jan. 7, 1910. No. 11793 D.

Experiments on the Work of Machine Tools (Expériences sur le Travail des Machines Outils). M. Codron. A continuation of the author's experiments, the first of which were described in the *Revue de Mécanique* in 1906 and 1907. This article discusses boring with an ordinary tool with rectilinear edge. Ills. Serial. 1st part. 6500 w. Rev de Mécan—Jan., 1910. No. 11926 E + F.

**Milling Cutters.**

A Milling Machine Attachment for Cutting Square Corners in Cotter Holes. Illustrated description. 600 w. Prac Engr—Jan. 21, 1910. No. 11379 A.

**Milling Machines.**

The New Kempsmith Universal Dividing Head. Illustrated detailed description. 1200 w. Ir Age—Feb. 3, 1910. No. 11416.

**Molding.**

Molding Patterns in Foundry Floor. Jabez Nall. Illustrates and describes the making of castings too large or too intricate for a flask. 1500 w. Am Mach—Vol. 33. No. 6. No. 11509.

**Molding Machines.**

European Molding Machine Practice.

*We supply copies of these articles. See page 158.*

Illustrated discussion of various kinds of molding machines. 2000 w. Foundry—Feb., 1910. No. 11335.

Team Work Machine Molding. Illustrated description of special work as applied to molds for car wheel centers, in the gray iron foundry of the Standard Steel Works, Burnham, Pa. 1500 w. Foundry, Feb., 1910. No. 11336.

Recent Molding Machines (Neuere Formmaschinen). Ernst A. Schott. Detailed description of the "Berkshire" machine built by Vogel & Schemmann, Kabel, Germany. Ills. Serial. 2 parts. 3000 w. Giesserei-Zeit—Jan. 1 and 15, 1910. No. 11768 each D.

**Pattern Shops.**

The Modern Pattern Shop. Abstract of an address by George F. Reinhard, before the Chicago Found. Foremen. Illustrates and describes details of arrangement and equipment of some representative plants. 3500 w. Ir Age—Feb. 17, 1910. No. 11627.

The Pattern Shop of To-Day. Joseph Leon Gobeille. Read before the Pittsburgh Found. Assn. Suggests changes that make for economy. 2200 w. Ir Age—Feb. 17, 1910. No. 11628.

**Screw Cutting.**

Thread Rolling. J. F. Springer. Principles and methods used are illustrated and described. 2000 w. Mach, N Y—Feb., 1910. No. 11351 C.

**Shop Heating.**

Heating a Shop Through Its Floors. Illustrated detailed description of a novel system in the plant of the Morse Chain Co., Ithaca, N. Y. 3000 w. Am Mach, Vol. 33, No. 6. No. 11506.

Heating and Ventilating Offices in Shops and Factories. Charles L. Hubbard. Describes several methods more or less efficient acording to cost. Ills. 2500 w. Mach, N Y—Feb., 1910. No. 11345 C.

**Shop Lighting.**

Illumination for Industrial Plants. G. H. Stickney. Treats of artificial illumination for the actual processes of manufacture. 2500 w. Pro Am Inst of Elec Engrs—Feb., 1910. No. 11973 F.

**Shop Practice.**

Shop Kinks. From the Mt. Clare Shops of the Balitmore & Ohio. F. E. Lister. Half-tone illustrations of tools and descriptions of methods used. 8500 w. Ry Age Gaz—Feb. 4, 1910. No. 11459.

Making the Marmon Car. Illustrates and describes fixtures used in boring cylinders, facing and reaming valve seats, and drilling and boring crank cases. 1500 w. Am Mach—Vol. 33, No. 8. No. 11894.

Locating Bevel Gears of Motor Car Axles. Hugh Dolnar. Deals with the bevel pinion and bevel-gear drive describing methods and special appliances used by a Cleveland company. Ills. 2500 w. Am Mach—Vol. 33, No. 7. No. 11637.

Machining Engine Standard, Cylinder and Guides. S. Lawrence. Prize paper. Describes in detail the operations. Ills. 2200 w. Mech Wld—Feb. 11, 1910. No. 11840 A.

Machining Buick Engine Cylinders. E. F. Lake. Illustrates and describes the various operations. 1000 w. Am Mach—Vol. 33, No. 7. No. 11636.

Machining Commutators. W. Burns. Describes the operation. Ills. 2000 w. Mech Wld—Feb. 4, 1910. No. 11608 A.

Laying-Out and Aligning Operations on Machine Tools. Alfred Spangenberg. Line engravings and suggestions for special cases. 2000 w. Mach, N Y—Feb., 1910. Serial. 1st part. No. 11349 C.

Automatic Turret Machine Building. F. A. Stanley. Illustrates and describes methods and tools used in a New Haven shop. 3000 w. Am Mach—Vol. 33, No. 5. No. 11418.

Making Automatic Turret Chucks. F. A Stanley. Illustrates and describes processes and special tools used in constructing automatic machine parts. 2200 w. Am Mach, Vol. 33, No. 6. No. 11507.

Shop Equipment and Practice in the German Niles Plant, Oberschöneweide (Betriebseinrichtungen und Arbeitsverfahren bei der Deutscher Niles-Werkzeugmaschinen-Fabrik in Oberschöneweide). G. Schlesinger. Ills. Serial. 1st part. 3200 w. Zeitschr d Ver Deutscher Ing—Jan. 29, 1910. No. 11945 D.

**Shops.**

A Modern Boiler Shop. E. R. Fish. Illustrated description of the Heine Safety Boiler Company's new shop at St. Louis, Mo., and its construction. 5000 w. Jour Assn of Engng Socs—Dec., 1909. No. 11958 C.

The Broad Oaks Ironworks of Messrs. Markham & Co. Limited, Chesterfield. Illustrated detailed description. Plate. 3000 w. Col Guard—Feb. 4, 1910. No. 11610 A.

**Shop Ventilation.**

See Shop Heating, under MACHINE WORKS AND FOUNDRIES.

**Tool Making.**

A Tool Designing System That Works Well. Diagrams and description of the system of the Thomas Motor Car Co. 600 w. Am Mach—Vol. 33, No. 7. No. 11640.

Piecework in the Tool-Room. H. Graham. Gives typical examples compiled from actual records, with general remarks. Ills. 1500 w. Prac Engr—Feb. 11, 1910. No. 11838 A.

**Tools.**

High Speed Steel Tools. Considers tools where the bit is held to the shank or body otherwise than by clamps. Ills. 2500 w. Ir Age—Feb. 24, 1910. No. 11867.

**Tool Storage.**

Tool Stores Arrangement. C. L.

Browne. Suggestions for the efficient storage and the supervision of their circulation in the works. 2000 w. Mech Wld—Feb. 4, 1910. Serial. 1st part. No. 11609 A.

**Welding.**

A Comparison of Welding Methods for the Repair of Castings. Translation of an article by E. Lamberton, in *Stahl und Eisen*. Discusses German and American practice. Ills. 4000 w. Met & Chem Engng—Feb., 1910. No. 11431 C.

Autogenous Welding (Die autogene Schweissung). A criticism by C. Diegel of H. Rinne's paper, and a reply by the latter. Ills. 3500 w. Stahl u Eisen—Jan. 26, 1910. No. 11756 D.

**Woodworking Machinery.**

A New High-Speed Lathe. Illustrated description of a novel lathe embodying new features. 1800 w. Engr, Lond—Feb. 11, 1910. No. 11848 A.

## MATERIALS OF CONSTRUCTION.

**Alloys.**

Ninth Report to the Alloys Research Committee: On the Properties of Some Allows of Copper, Aluminium and Manganese. (With an appendix on the Corrosion of Alloys of Copper and Aluminium when Exposed to the Sea). Dr. W. Rosenhain and F. C. A. H. Lantsberry. Ills. 3500 w. Inst of Mech Engrs—Jan. 21, 1910. No. 11535 N.

Determination of the Points of Transformation of Copper-Aluminium Alloys (Détermination des Points de Transformation des Alliages Cu-Al). Maurice Barrée. A study of the variation of electrical resistance with temperature. Ills. 5200 w. Rev de Métal—Jan., 1910. No. 11709 E + F.

**Alloy Steels.**

Special Steels. Leon Guillet. Translated from the French. A paper presented at the Cong. of the Int. Assn. for Test. Mat. 2500 w. Ir Trd Rev—Feb. 3, 1910. No. 11436.

**Aluminium Bronze.**

Aluminium Bronze and What Can Be Done With It; Its Good and Bad Qualities. Erwin S. Sperry. Discusses the difficulty in casting, and hot rolling and forging. Ills. 1800 w. Brass Wld—Jan., 1910. No. 11676.

**Brass.**

The Failure of Non-Ferrous Metals and Alloys. T. Vaughan Hughes. Read before the Inst. of Metals. Reports an investigation of failure in practice of non-ferrous metals and alloys, with particular reference to brass loco-tubes. 2500 w. Engng—Jan. 21, 1910. No. 11394 A.

**Fatigue.**

An Inquiry on the "Fatigue of Metals" (Enquête sur la "Fatigue des Métaux"). A symposium of replies by eminent metallurgists to a list of questions dealing with fatigue in metals. Serial. 1st part. 2000 w. Tech Mod—Jan., 1910. No. 11715 D.

**Metallography.**

A Report on the Progress of Metallography from the Brussels Congress to the Beginning of 1909 (Rapport sur les Progrès de la Métallographie depuis le Congrès de Bruxelles jusqu'au Commencement de l'Année 1909). E. Heyn. Presented at the Copenhagen congress of the Int. Assn for Testing Mat. 8000 w. Rev de Métal—Jan., 1910. No. 11710 E + F.

**Steel.**

Steel for Gears. Abstract of a report by L. P. M. Revillon, of Paris, of elaborate tests to determine the ideal combination of chemical and physical properties. 1400 w. Ir Age—Feb. 3, 1910. No. 11417.

Effect of Twisting on Iron and Steel Bars. Reports tests which show a remarkable increase in tensile strength and elastic limit. Ills. 1000 w. Ir Trd Rev. Feb. 3, 1910. No. 11435.

Investigations of the Hardness of Tempered Steels and Particularly of the Hardness of Cemented and Tempered Steels (Expériences sur la Dureté des Aciers trempés et particulièrement sur la Dureté des Aciers cémentés et trempés). A. Portevin and H. Berjot. Gives the results of an extended research. Ills. 6500 w. Rev de Métal—Jan., 1910. No. 11711 E + F.

A Study of the Gases Liberated by the Action of Cupric Salts on Steels (Etude des Gaz dégagés par l'Action des Sels cuivriques sur les Aciers). E. Goutal. Results of a study of the occlusion of gases in steel. Ills. 4000 w. Rev de Métal—Jan., 1910. No. 11708 E + F.

**Tool Steels.**

Development and Use of the New High-Speed Steels. Walter Carter. Read before the Birmingham Assn. of Mech. Engrs. Aims to show that steels are now made as much in advance of the ordinary high-speed steels as those were in advance of the steels they displaced. 4000 w. Engr Lond—Feb. 11, 1910. No. 11849 A.

**Wire Rope.**

The Elasticity of Clean, Rusted, and Galvanized Wire (Die Elastizität blanker, verrosteter und verzinkter Seildrähte). Julius Divis. An exhaustive discussion of the strength of wire rope. Serial. 1st part. 4000 w. Oest Zeitschr f Berg u Hüttenwesen—Jan. 29, 1910. No. 11760 D.

See also same title, under MINING AND METALLURGY, MINING.

## MEASUREMENT.

**Calorimetry.**

Calorimetry. Charles L. Hubbard. Illustrates and describes the separator and throttling calorimeters. 2000 w. Elec Rev, N Y—Jan. 29, 1910. No. 11331.

**Dynamometers.**

See Motor Testing, under AUTOMOBILES.

**Gas Meters.**

The Measurement of Gas Velocities and Volumes (Messung von Gasgeschwindigkeiten und Gasmengen). A. Dosch. Describes various types of apparatus. Ills. 4200 w. Stahl u Eisen—Jan. 19, 1910. No. 11753 D.

**Gauges.**

The Normal Temperature of Gauges (Die Normaltemperatur von Endmass-Normalien und Massstäben). Carl Mahr. Discusses the effect of temperature on the accuracy of instruments of precision. Ills. 2000 w. Zeitschr f Werkzeug—Jan. 15, 1910. No. 11786 D.

**Hardness.**

A New Sclerometer. A. L. Parsons. Illustrated description of a new instrument in which the force necessary to make a scratch is measured by a spring and not by weights. 2000 w. Am Jour of Sci—Feb., 1910. No. 11819 D.

**Impact Testing.**

See Testing Machines, under MEASUREMENT.

**Laboratories.**

The New Laboratories of the University of Toronto, for Steam, Gas and Hydraulic Work. Robert W. Angus. Illustrated detailed description of the building and the equipment. 8000 w. Ap Sci—Feb., 1910. No. 12012 C.

**Pitot Tube.**

Various Types of Pitot Tube (Ueber verschiedene Formen Pitotscher Röhren). H. Blasius. Mathematical discussion of various types. Ills. 4000 w. Die Turbine—Jan. 20, 1910. No. 11780 D.

**Pressure Gauges.**

Notes on Some Errors of Fluid Differential Gages. George Jacob Davis, Jr. Explanatory notes concerning such gages and the cause and effect of the more common errors to which they are liable. 3000 w. Eng News—Feb. 24, 1910. No. 11876.

Differential Gauge for Measuring Small Pressures. Jas. Alex. Smith. Illustrated description of an instrument of the two-fluid type. 2500 w. Aust Min Stand—Jan. 5, 1910. No. 11599 B.

**Pyrometry.**

Recent Progress in Industrial Pyrometry. Charles R. Darling. An account of new forms of pyrometers, pointing out their distinctive improvements. Ills. 3800 w. Engr, Lond—Feb. 11, 1910. No. 11843 A.

Several Varieties of European Pyrometers. Charles E. Foster. Discusses their application and operation in the heat treatment of steel. Ills. 3000 w. Am Mach—Vol. 33, No. 7. No. 11639.

**Steam Meters.**

The "Sarco" Steam Recorder. Illustrated description of an instrument for measuring and recording the flow of steam. 1500 w. Engng—Jan. 28, 1910. No. 11539 A.

**Testing Machines.**

The Charpy Impact Testing Machine. Illustrates and describes types, explaining the action. 1000 w. Engng—Jan. 21, 1910. No. 11390 A.

**Venturi Meters.**

Venturi Tests for Boiler Feed. Discussion of C. M. Allen's paper on this subject. 2000 w. Jour Am Soc of Mech Engrs—Feb., 1910. No. 11990 F.

**Verniers.**

The Vernier Scale—Its Principle and Method of Reading. Diagrams and information, with supplement. 900 w. Mach, N Y—Feb., 1910. No. 11352 C.

## POWER AND TRANSMISSION.

**Air Compressors.**

Compressing Air by Water. George C. McFarlane. Illustrates and describes a number of systems for air compression. 2200 w. Min & Sci Pr—Feb. 19, 1910. No. 11888.

Costs of Producing Compressed Air in a Canadian Mining Camp. Richard L. Webb. Aims to show the real effiiciency of air compressors as found under ordinary working conditions. 1500 w. Can Min Jour—Feb. 15, 1910. No. 11803.

The Intake Pressure in Air Compressor Cylinders. Letters from E. A. Rix and S. B. Redfield discussing the inertia of air entering the inlet pipe of an air-compressor cylinder. 2000 w. Compressed Air—Feb., 1910. No. 12015.

Recent Air Compressors (Compresseurs nouveaux). A review of recent progress, improvements and inventions in the air-compressor field. Ills. 7000 w. Rev de Mécan—Jan., 1910. No. 11928 E + F.

**Electric Driving.**

The Applicability of Electrical Power to Industrial Establishments. Dugald C. Jackson. Describes the present status of electrical power in factories, pointing out changes which have arisen. 2500 w. Pro Am Inst of Elec Engrs—Feb., 1910. No. 11970 F.

Central Stations versus Isolated Plants for Textile Mills. Charles T. Main. Considers factors affecting the cost of power, the requirements of textile mills, advantages and disadvantages, cost, etc. 4500 w. Pro Am Inst of Elec Engrs—Feb., 1910. No. 11971 F.

Electric Drive in Foundries, Works, and Mines. Hubart A. Carter. Explains the advantages of the electric drive over other means of power transmission. 3500 w. Min and Sci Pr—Feb. 5, 1910. No. 11554.

The Powering of Boiler Shops. D. S. Downs. Discusses the most important points which determine the boiler shop equipment. 1600 w. Boiler Maker—Feb., 1910. Serial. 1st part. No. 11502.

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Electrical Drive for Rolling Mills. Dr. A. S. McAllister. Discusses the adaptation of electric motors to this service, the advantages of electric drive, etc. 2000 w. Met & Chem Engng—Feb., 1910. No. 11428 C.

**Lubrication.**

Lubrication and Lubricants. Charles F. Mabery. Presents results of extensive tests made with the Carpenter machine for testing lubricants, referring particularly to deflocculated graphite. 6000 w. Jour Am Soc of Mech Engrs—Feb., 1910. No. 11987 F.

The Emulsification of Oils in Turbines, Crank Chambers, etc. Jas. E. Southcombe. Discusses the objections to emulsions in lubrication and gives an account of research work with the object of preventing objectionable emulsions. 1500 w. Elec Rev, Lond—Feb. 11, 1910. No. 11831 A.

**Power Generation.**

The Importance of Mechanical Power. Charles Edward Lucke. Abstract of first Hewitt lecture, delivered at Cooper Union Hall, N. Y. City. Reviews the progress made in power generation. 2500 w. Power—Feb. 15, 1910. No. 11591.

The Development of Power Systems. Charles Edward Lucke. Abstract of second Hewitt lecture at Cooper Union hall, N. Y. City. Discusses natural laws and physical processes applied in power systems. 2500 w. Power—Feb. 22, 1910. No. 11864.

**Power Plants.**

Power Plant Wastes. Percival Robert Moses. Gives instances of preventable wastes in power plant operation. 4000 w. Cassier's Mag—Feb., 1910. No. 11668 B.

A Recent Comparison of Turbines and Engines. Warren H. Miller. Gives tables and results of a recent comparison between high-speed simple Corliss engines, high-speed tandem compounds and steam turbines, made in connection with the selection of engines or turbines for an industrial plant. 2000 w. Eng Rec—Feb. 19, 1910. No. 11683.

Mixed Pressure Turbine and Engine Plants. H. Y. Haden. Explains the possibilities of this combination for manufacturing plants of moderate size where the load is variable and there is frequent demand for exhaust steam for heating purposes. 3500 w. Power—Feb. 1, 1910. No. 11341.

The Power Station of the Allis-Chalmers Works. Illustrated description of this Milwaukee plant showing interesting features in the combination of the power, water supply and sewage disposal systems. 4000 w. Eng Rec—Feb. 12, 1910. No. 11588.

## STEAM ENGINEERING.

**Boiler Design.**

Boiler Explosions and Riveted Joints. James Crombie. Abstract of an address delivered before the Hamilton branch of the C. A. S. E. Considers the best form of joint and the mathematical determination of the working pressure. 1200 w. Boiler Maker—Feb., 1910. No. 11503.

**Boiler Draft.**

See Flue Gases, under STEAM ENGINEERING.

**Boiler Explosions.**

See Boiler Design, under STEAM ENGINEERING.

**Boiler Feeding.**

See Venturi Meters, under MEASUREMENT.

**Boiler Fittings.**

Safety Devices for Steam Boilers (Les Appareils de Sureté des Chaudières à Vapeur). F. Sinigaglia. Describes and discusses types of water level indicators. Ills. 3200 w. Rev de Mécan—Jan., 1910. No. 11927 E + F.

**Boiler Furnaces.**

A Furnace for Tanbark and Similar Fuels Description given by A. A. Cary in discussion of a paper by D. M. Myers. Illustrates the McMurray furnace. 1500 w. Power—Feb. 1, 1910. No. 11342.

Tests of Two Types of Tile-Roof Furnaces Under a Water-Tube Boiler. J. M. Snodgrass. An illustrated report of tests made for the purpose of comparing boiler performance when operating with two types of furnace roofs. 3000 w. Univ of Ill, Bul. No. 34—May 10, 1909. No. 11811 N.

Boiler Plants and their Management (Industrielle Feuerungsanlagen und ihre Behandlung). Heinrich Hempel. Discusses particularly boiler furnaces and firing. 2500 w. Oest Zeitschr f Berg u Hüttenwesen—Jan. 1, 1910. No. 11757 D.

**Boiler Leakage.**

An Experience with Leaky Vertical Fire-Tube Boilers. F. W. Dean's paper on the difficulties experienced with such boilers is discussed generally. Ills. 4500 w. Jour Am Soc of Mech Engrs—Feb., 1910. No. 11993 F.

**Boiler Management.**

How to Burn Coal Economically. W. R. Allen. Describes how the gases of an ordinary furnace may be consumed and burned. Ills. 1500 w. Sci Am—Feb. 5, 1910. No. 11405.

The Tax Exacted from Excess Air. Henry J. Westover. Gives results of boiler tests showing the waste from this cause and the remedy. 1500 w. Power—Feb. 1, 1910. No. 11343.

**Boilers.**

An Interesting Chapter of Boiler History. Illustrated description of some experimental hydraulic bursting tests con-

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ducted in 1872, '73 and '74 by the Manchester Steam Users' Assn. 2500 w. Mech Engr—Feb. 4, 1910. No. 11606 A.

The Parker Down-Flow Water-Tube Boiler. Illustrated detailed description of a type constructed in Philadelphia, Pa. 3000 w. Engng—Feb. 4, 1910. No. 11614 A.

Features of the Manning Boiler. S. F. Jeter. Illustrated description of the general construction, operative features, etc. 2500 w. Power—Feb. 15, 1910. No. 11590.

**Condenser Tubes.**

The Diameter of Condenser Tubes. R. M. Neilson. Discusses the subject of best tube diameters. 2800 w. Engr, Lond—Jan. 21, 1910. No. 11395 A.

**Condenser Water.**

See Sewage Disposal, under CIVIL ENGINEERING, MUNICIPAL.

**Engine Lubrication.**

Cylinder Lubrication in Steam Engines and Combustion Motors (Die Zylinderschmierung der Dampfmaschinen und Verbrennungsmotoren). L. Weiss. Details results of investigations. 5000 w. Zeitschr d Ver Deutscher Ing—Jan. 22, 1910. No. 11944 D.

**Engines.**

Lentz System of Short-Built Tandem Compound Steam Engines. Illustrated detailed description. 800 w. Engng—Jan. 21, 1910. No. 11387 A.

Paul H. Müller Tandem Compound Engine with Drop-Valve Gear (Tandem-Maschine mit Ventilsteuerung System Paul H. Müller). Describes an engine built by the Zwickauer Maschinenfabrik A.-G. Ills. Serial. 1st part. 1000 w. Elektrotech Rundschau—Jan. 5, 1910. No. 11909 D.

**Engine Tests.**

Test of a Compound Semi-Stationary Superheated Steam Engine. Illustrated description of a 50 B. H. P. semi-stationary compound superheat steam engine, with report of test showing remarkably low fuel consumption. 3000 w. Engr, Lond—Feb. 4, 1910. No. 11619 A.

**Flue Gases.**

The Specific Weight of Flue Gases and Chimney Draft (Betrachtungen über das spezifische Gewicht der Rauchgase und den Schornsteinzug). Leopold Nowotny. Mathematical discussion. Ills. 2000 w. Oest Wochenschr f d Oeffent Baudienst—Jan. 29, 1910. No. 11904 D.

**Fuels.**

Tan Bark as a Boiler Fuel. David Moffat Myers. Addition, by the author, to a paper published in the October Journal, with general discussion. Ills. 4500 w. Jour Am Soc of Mech Engrs—Feb., 1910. No. 11988 F.

**Indicators.**

The Steam Indicator. Illustration and description of the indicator and the method of taking diagrams. 900 w. Ry & Loc Engng—Feb., 1910. No. 11451 C.

**Steam Piping.**

Notes on Piping Systems for Steam Power Plants. A. G. Christie. Directions for the laying out of pipe lines. 2200 w. Ap Sci—Feb., 1910. No. 12014 C.

Economical Velocities in Steam Piping. Perry West. Discusses factors that must be considered in computing the steam velocity in piping. 1200 w. Power—Feb. 22, 1910. No. 11863.

Economical Velocities in Steam Piping. Perry West. Gives charts showing the most economical steam velocities and the corresponding size of pipe required. 2000 w. Power—Feb. 8, 1910. No. 11496.

Different Designs of Expansion Joint. Warren O. Rogers. Illustrated descriptions of several standard types, their construction and applications. 2000 w. Power—Feb. 22, 1910. No. 11865.

Strains and Stresses in Expansion Pipes (Formänderung und Beanspruchung federnder Ausgleichröhren). A. Bantlin. A theoretical consideration of expansion bends in steam pipe lines. Ills. 3700 w. Zeitschr d Ver Deutscher Ing—Jan. 1, 1910. No. 11936 D.

**Thermic Accumulators.**

See Central Stations, under ELECTRICAL ENGINEERING, GENERATING STATIONS.

**Thermodynamics.**

Evaluation of the Cooling Effect of Expansion without Sensible External Work (Evaluation du Froid obtenu dans une Détente effectuée sans Travail extérieur sensible). C. Monteil. Points out the inaccuracy of the Joule-Thomson formula, and demonstrates a method of calculation based on the empirical formulæ of Van der Waals, Clausius or Sarrau. 3000 w. Mem Soc Ing Civ de France—Nov., 1909. No. 11702 G.

**Turbine Balancing.**

Balancing of High-Speed Turbine Shafts. A. E. Hunt. Gives an analysis of the bending action and stresses. 1000 w. Prac Engr—Feb. 4, 1910. No. 11603 A.

**Turbines.**

The De Laval Steam Turbine. W. O. Beyer. Outlines briefly the development of the modern steam turbine and describes in detail the De Laval invention. Ills. 5700 w. Sib Jour of Engng—Feb., 1910. Serial. 1st part. No. 12002 C.

Elementary Theory of the Steam Turbine. William E. Snow. Illustrated explanation of impulse and reaction forces and how they are combined in modern turbines. 1500 w. Power—Feb. 22, 1910. No. 11862.

The Application of the Steam Turbine to the Driving of Textile Mills. G. B.

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Storie. Read before the Manchester Assn. of Engrs. Discusses important questions relating to the installing and operating of turbine plants in mills driven by mechanical as well as electrical power. 2000 w. Mech Engr—Jan. 28, 1910. Serial. 1st part. No. 11533 A.

Steam Turbines and Turbo-Dynamos (Ueber Dampfturbinen und Turbodynamos). P. Ehrlich. A review of the progress and improvements of recent years. Ills. Serial. 1st part. 2200 w. Elektrotech u Maschinenbau—Jan. 2, 1910. No. 11918 D.

See also Central Stations, under ELECTRICAL ENGINEERING, GENERATING STATIONS.

**Turbine Tests.**

Tests on a Schulz Turbine (Versuche mit einer Schulz-Turbine). M. F. Gutermuth. Describes the machine and the tests and gives the results. Ills. 4000 w. Zeitschr d Ver Deutscher Ing—Jan. 8, 1910. No. 11938 D.

Test of a 1,000 Horse Power Steam Turbine of the Sächsischen Maschinenfabrik, with Special Refernce to the Influence of the Shrouding and Blade Spacing (Untersuchung einer 1000 PS—Dampfturbine der Sächsischen Maschinenfabrik, insbesondere über den Einfluss von Bandagen und Schaufelteilung). E. Josse. Ills. 4500 w. Zeitschr d Ver Deutscher Ing—Jan. 30, 1910. No. 11785 D.

**Vacuum.**

Diagram Indicating the Percentage of Vacuum Corresponding to Readings of the Mercury Vacuum Motor (Tabelle zum sofortigen Ablesen des Vakuums in Prozenten am Quecksilbervakuummeter). Hans Neubauer. Ills. 1700 w. Oest Zeitschr f Berg u Hüttenwesen—Jan. 15, 1910. No. 11758 D.

## TRANSPORTING AND CONVEYING.

**Coal Handling.**

A New Type of Self-Discharging Coaling Vessel. F. C. Coleman. Illustrated description of a new system of belt-conveyor discharge. 1200 w. Sci Am—Feb. 26, 1910. No. 11882.

See also Piers, under CIVIL ENGINEERING, WATERWAYS AND HARBORS.

**Conveyors.**

Coal Conveyor for Loading Ships. Illustrated description of a conveyor designed by Wilson Worsdell. 700 w. Engr, Lond—Jan. 28, 1910. No. 11545 A.

**Cranes.**

100-Ton Giant Crane. Illustrates and describes a giant crane recently erected at the engine works of George Clark, Limited, Sunderland. It consists of a four-sided tower fixed to foundations, and having a roller path on the top, upon which the horizontal jib revolves. 1500 w. Engr, Lond—Feb. 11, 1910. No. 11850 A.

A New Graphical Method of Determining Stresses in Crane Trusses (Ein neues graphisches Verfahren zur Bestimmung der grössten Stabkräfte im Kranparabelträger). Hermann Weidemann. Mathematical discussion of a special case. Ills. 2500 w. Zeitschr d Ver Deutscher Ing—Jan. 29, 1910. No. 11947 D.

**Dock Machinery.**

The Electrical Equipment of Smith's Docks, North Shields. Illustrated description of equipment for these dry-docks and ship-repairing works. 2000 w. Elec Engr, Lond—Feb. 4, 1910. No. 11600 A.

**Elevators.**

Some Recent Electric Mountain Elevators (Einige neuere elektrische Berg-Aufzüge). W. A. Müller. Illustrated description of a number of novel lifts. Serial. 1st part. 1200 w. Glasers Ann—Jan. 15, 1910. No. 11791 D.

**Freight Handling.**

See same title, under RAILWAY ENGINEERING, TRAFFIC.

## MISCELLANY.

**Aeronautics.**

Aeronautics in 1909 (Le Bilan de l'Aéronautique en 1909). L. Marchis. A review of progress. Ills. Serial. 1st part. 2000 w. Tech Mod—Jan., 1910. No. 11713 D.

The Pioneer of Aerial Flight. Alexander Graham Bell. Abstract of an address delivered at the presentation of the Langley medal to the Wright brothers. Reviews briefly the work of Samuel Pierpont Langley. 1200 w. Sci Am Sup—Feb. 26, 1910. No. 11885.

An Experimental Station for Airships and Flying-Machines. Brief account of the arrangements adopted at Göttengen, by Prof. L. Prandtl. 1200 w. Engng—Feb. 4, 1910. No. 11617 A.

A Novel American Monoplane. Illustrated description of the invention of A. L. Pfitzner. 1500 w. Sci Am—Feb. 12, 1910. No. 11548.

America's First Aviation Meet at Los Angeles. Illustrated detailed account of the flights made by the American and French aviators. 2000 w. Sci Am—Jan. 29, 1910. No. 11300.

The Flow of Fluids over Plane Surfaces (Die Strömung von Flüssigkeiten über Flächen). A. Rateau. Mathematical discussion of the design of aeroplane propellers. Ills. 4000 w. Die Turbine—Jan. 5, 1910. No. 11778 D.

**Air Resistance.**

The Resistance of the Air According to Recent Investigations (Der Luftwiderstand auf Grund der neueren Versuche). W. Schüle. Reviews the results of recent experiments and draws conclusions.

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Ills. Serial. 1st part. 4700 w. Zeitschr d Ver Deutscher Ing—Jan. 1, 1910. No. 11934 D.

**Clocks.**

The Metropolitan Tower Clock in New York City. Joseph B. Baker. Illustrated detailed description of this immense clock, its lighting, chimes, and the electrical equipment. 2000 w. Elec Rev, N Y—Feb. 19, 1910. No. 11694.

**Guns.**

Progress in Ordnance Construction (Die Fortschritte im Geschützbau). J. Castner. A critical review of Lieut. Dawson's paper on "The Engineering of Ordnance "before the Junior Inst. of Engrs. Ills. 2800 w. Stahl u Eisen—Jan. 19, 1910. No. 11754 D.

**Mechanical Engineering.**

Lines of Development in Engineering (Entwicklungslinien der Technik). Prof. Kammerer. A review of development in power production and distribution, railway traction, material handling, etc. Ills. 8500 w. Tech u Wirt—Jan., 1910. No. 11929 D.

# MINING AND METALLURGY.

## COAL AND COKE.

**Accidents.**

Coal Mining Accidents in the United States and Their Prevention. J. A. Holmes. Reprint of paper presented before the Nat. Civ. Fed. of N. Y. Suggests remedies or means of lesssening accidents. 1000 w. Cassier's Mag—Feb., 1910. No. 11675 B.

Accidents in Shafts. F. H. Wynne. Summary of a report of a committee appointed by the Royal Committee on Mines to inquire into the causes and means of preventing accidents from falls of ground, unoergrouna haulage and in shafts. 7000 w. Col Guard—Feb. 4, 1910. No. 11612 A.

**Alaska.**

Conservation and Alaskan Coal. H. Foster Bain. Maps, coal analysis, and information in regard to these coal fields. 3000 w. Min & Sci Pr—Jan. 29, 1910. No. 11446.

See also British Columbia, under COAL AND COKE.

**Australia.**

Coal Measure of South-East Moreton. E. O. Marks. A report chiefly of the Trias Jura system, dealing with the various formations. Maps & Ills. 12500 w. Queens Gov Min Jour—Jan., 1910. Serial. 1st part. No. 11593 B.

**British Columbia.**

Coking Coal Deposits of the Pacific Northwest. H. Cole Estep. Considers the supplies of Washington and British Columbia and the deposits along the southern coast of Alaska. Maps. 3000 w. Ir Trd Rev—Jan. 27, 1910. No. 11313.

**Coke Ovens.**

Evence-Coppée Waste Heat Coke Oven Plant at Pinxton. Illustrated description of a plant near Nottingham, Eng. 2000 w. Col Guard—Feb. 11, 1910. No. 11841 A.

Concrete Coke-Oven Construction. E. A. Lee. Illustrated description of the method of construction, reinforcement, etc. 3300 w. Mines & Min—Feb., 1910. No. 11440 C.

**Coking By-Products.**

See Blast-Furnace Gas, under IRON AND STEEL.

**Drying.**

See same title, under ORE DRESSING AND CONCENTRATION.

**Electric Power.**

Electricity in Mines: Some Practical Considerations. Robert Nelson. Abstract of paper and discussion before the Birmingham Univ. Min. Soc. Considers the electrical equipment for haulage, pumping and lighting. 6000 w. Col Guard—Feb. 4, 1910. No. 11613 A.

Electrical Installation at Cannock Chase Colliery. Illustrated detailed description of the electrification of this colliery in South Staffordshire, England. 2500 w. Ir & Coal Trds Rev—Feb. 4, 1910. No. 11625 A.

**France.**

See same title, under IRON AND STEEL.

**Hardness.**

The Relative Hardness of Coal, and Its Influence on Wages. Trans. from *Glückauf*. Aims to establish a comparative relation between the hardness and cost of coal mining. 1200 w. Col Guard—Feb. 4, 1910. No. 11611 A.

**Illinois.**

The Longwall Mines of Illinois. W. F. Peltier. Gives plan and describes the method of operation. 1200 w. Eng & Min Jour—Feb. 12, 1910. No. 11583.

**India.**

The Colliery Manager in India. W. H. Pickering. Read before the Nat. Assn. of Col. Mgrs. Considers their duties, the mines they manage, and the mining industry. 4500 w. Ir & Coal Trds Rev—Jan. 21, 1910. No. 11402 A.

**Mine Dust.**

Investigations on the Drying of Mines and the Control of Mine Dust (Unter-

suchungen über die Austrocknung der Grubenbaue und die Bekämpfung des Kohlenstaubes). Herr Forstmann. An exhaustive discussion of the dangers of coal dust and of various methods used for combatting them. Ills. Serial. 1st part. 7000 w. Glückauf—Jan. 15. 1910. No. 11762 D.

**Mine Railway.**

A European Electric Colliery Railway. J. B. Van Brussel. Illustrates and describes a line connecting a colliery with a new opening, 2¼ miles distant, enabling the seams to be worked economically. 1200 w. Eng & Min Jour—Feb. 12, 1910. No. 11582.

**Mining.**

Mining Coal with Explosives. Considers the effect of explosives in coal mining as influenced by the positions of the holes in which they are fired. Diagrams. 2500 w. Mines & Min—Feb., 1910. No. 11442 C.

Machine Mining, with Special Reference to South Wales. Sam Mavor. Abstract of a paper read before the S. Wales Inst. of Engrs. Deals with longwall mining in which system machinery can be used to advantage. 4500 w. Ir & Coal Trds Rev—Jan. 28, 1910. Serial. 1st part. No. 11546 A.

**Mining Plants.**

Outside Arrangements of Modern Coal Mine. Warren R. Roberts. Discusses the conditions which govern the production of coal with reference to the design of the surface mining plant. Ills. 3000 w. Eng & Min Jour—Feb. 19, 1910. No. 11692.

An Alabama Coal Mine Power Plant. Warren O. Rogers. Illustrated description of a boiler house located on a hill side, the fuel being delivered by gravity. 1200 w. Power—Feb. 8, 1910. No. 11495.

**Occluded Gases.**

A Study of the Condition of Gas in Coal. Rollin T. Chamberlin. Abstract from a Bulletin of the U. S. Geological Survey. 4500 w. Min Wld—Feb. 5, 1910. No. 11493.

**Pennsylvania.**

A Typical River Mine in Pennsylvania. Floyd W. Parsons. Illustrates and describes a rather uncommon system of handling the coal at the Crescent mine, near California, Penn. Map. 1200 w. Eng & Min Jour—Feb. 5, 1910. No. 11476.

**Siberia.**

Mining in Siberia. R. M. Percy. Abstract of a paper, presented to the Nat. Assn. of Col. Mgrs., describing conditions and methods of coal mining in Siberia, and the difficulties met. Ills. 5000 w. Ir & Coal Trds Rev—Jan. 28. 1910. No. 11547 A.

## COPPER.

**Arizona.**

Geology at Globe, Arizona. F. L. Ransome. Notes based on a recent study of this copper district. 2000 w. Min & Sci Pr—Feb. 12, 1910. No. 11633.

**Low-Grade Ores.**

Engineering and Economic Aspects of Low-Grade Copper Deposits. C. F. Tolman. Shows the importance of low-grade ores and calls attention to deposits in the United States of chalcocite disseminations in schists. Ills. 3000 w. Engineering Magazine—March, 1910. No. 11982 B.

**Nevada.**

Montgomery-Shoshone Mine. A. H. Martin. Describes this mine and its development and ore treatment. 1500 w. Min & Sci Pr—Feb. 19, 1910. No. 11890.

**Russia.**

See same title, under GOLD AND SILVER.

**Smelters.**

International Smelting & Refining Co.'s Plant. Leroy A. Palmer. Illustrated detailed description of this plant under construction in Utah. 2500 w. Min Wld—Feb. 19, 1910. No. 11801.

**Smelting.**

Matte Smelting at Denver. H. Foster Bain. Discusses the general condition of the industry, especially the Argo smelter, the Modern smelter, and the Golden smelter. Ills. 2500 w. Min & Sci Pr—Feb. 12, 1910. No. 11631.

## GOLD AND SILVER.

**Colorado.**

Recent Developments on Iron Hills, Leadville. George O. Argall. Discusses the geology, history, recent developments, ore deposits, etc. Ills. 4500 w. Eng & Min Jour—Jan. 29, 1910. No. 11327.

See also Ore Deposits, under MISCELLANY.

**Cyaniding.**

All Slime Treatment of Ore in Cyanide Plants. H. A. Megraw. Shows that no one system is suitable for all ores. Advocates a rough separation of slimes and sands, discussing economy and efficiency. 2000 w. Eng & Min Jour—Feb. 5, 1910. No. 11474.

A Rotary Extractor for Precious Metals from Solutions. W. D'Arcy Lloyd and Ernest T. Rand. Illustrated description of the machine with report of results. 2500 w. Jour Chem, Met & Min Soc of S. Africa—Dec., 1909. No. 11598 E.

Cyanide-Plant and Practice at the Minas del Tajo, Rosario, Sinaloa, Mexico. George A. Tweedy and Roger L. Beals. Illustrated detailed description, showing the progress being made. 11600 w. Bul Am Inst of Min Engrs—Feb., 1910. No. 11985 F.

**Dredging.**

Gold Dredging at Parocale. An account of work on the southeast coast of the Island of Luzon, Philippine Islands. 1500 w. Min & Sci Pr—Feb. 12, 1910. No. 11634.

Rock Crushing Plant Reclaiming Dredge Lands. A. H. Martin. Illustrated account of methods of removing and utilizing the debris, and restoring the ground for cultivation. 1600 w. Min Wld—Feb. 5, 1910. No. 11491.

See also Liberia, under GOLD AND SILVER.

**Idaho.**

Equipment and Methods at the Hecla Mine. Roy Hutchins Allen. Describes the development of this mine in the Coeur d'Alene district by levels at 300 ft. intervals. The Ilgner electric hoisting system is used. 3000 w. Eng & Min Jour—Feb. 5, 1910. No. 11473.

**India.**

The Great Ooregum Indian Gold Mine. T. Lington. Gives information relating to the extent and value of one of the most important gold mines in India. 1200 w. Min Wld—Jan. 29, 1910. No. 11324.

**Mexico.**

The Early Mining History of Pachuca, Mexico. Morrill B. Spaulding. An illustrated historical review. 3000 w. Min Wld—Feb. 19, 1910. No. 11800.

Mines of Ajuchitlan, Queretaro, Mexico. Samuel J. Lewis. Illustrated description of the deposits, and a study of the geology. 3500 w. Min & Sci Pr—Feb. 5, 1910. No. 11553.

Sonora, Mexico, in 1909. F. J. H. Merrill. A review of the mining industry during the year in the production of copper, gold and silver. 1500 w. Min & Sci Pr—Jan. 22, 1910. No. 11326.

**Nevada.**

Report of Goldfield Con. Mines Co., Nevada. Jos. H. McKenzie. Report of construction, mining, ore production, transportation, treatment and costs for the past year. Ills. 3500 w. Min Wld—Jan. 29, 1910. No. 11322.

**Philippines.**

See Dredging, under GOLD AND SILVER.

**Refining.**

Gold Refining. An account of a simple modification of the Wohlwill process which appears to greatly broaden its scope and applicability. The use of a pulsating current instead of a constant direct current. 2200 w. Met & Chem Engng—Feb., 1910. No. 11430 C.

**Review of 1909.**

Survey's Preliminary Gold and Silver Review. Waldemar Lindgren and H. D. McCaskey. Brief reviews of the conditions of this industry in the most important states and territories. 7000 w. Min Wld—Jan. 29, 1910. No. 11323.

**Russia.**

Russia's Gold and Copper Production. Official statistics are examined. 2200 w. Min Jour—Jan. 22, 1910. No. 11380 A.

**Siberia.**

Siberian Dredging Statistics for 1908. Jerome B. Landfield. Gives a resumé of statistics gathered by the Gold & Platinum Miners' Assn. of Russia, showing conditions. 1000 w. Min & Sci Pr—Jan. 22, 1910. No. 11325.

**Slag Reduction.**

Slag Reduction. Brief description of a slag furnace used at Taracol, Korea. Ills. 900 w. Min & Sci Pr—Feb. 5, 1910. No. 11555.

**Tibet.**

Gold Mines of Tibet. Alexander Del Mar. Reviews the history of these mines as far as recorded. 2000 w. Min & Sci Pr—Feb. 12, 1910. No. 11632.

## IRON AND STEEL.

**Alabama.**

Mineral Resources of the Birmingham District. Ernest F. Burchard. An illustrated description of the geology, topography, ore deposits, mining methods, etc. Maps. 5000 w. Mfrs' Rec—Feb. 17, 1910. No. 11626.

**Blast-Furnace Gas.**

The Direct Production of Ammonium Sulphate (Ein Beitrag zur Geschichte der direkten Verfahren zur Gewinnung von schwefelsaurem Ammoniak). Otto Ohnesorge. Reviews the Addie, Mond, Brunck, Otto, and other processes for extracting ammonium sulphate from blast-furnace and coke-oven gases. Ills. 2500 w. Stahl u Eisen—Jan. 19, 1910. No. 11752 D.

**Blast Furnaces.**

Blast Furnace No. V. of the Alexandrosky Works, South Russia. M. A. Pavloff. Illustrated description of the largest blast furnace in Russia, and of interesting details of the hoisting equipment. 800 w. Engr, Lond—Jan. 21, 1910. No. 11398 A.

**Blast-Furnace Slag.**

Barium in Blast Furnace Slag. R. H. Sweetser. Reports observations made while having a slag with BaO in it, suggesting experimental investigation. 600 w. Ir Age—Feb. 3, 1910. No. 11415.

The Manufacture of Portland Cement from Blast Furnace Slag. Describes the plant and methods used at the Newmains works for the production of cement. Ills. 1500 w. Engr, Lond—Jan. 21, 1910. No. 11396 A.

**Dry-Air Blast.**

The Daubiné and Roy Process for Drying Blast-Furnace Air by Means of Calcium Chloride (L'Emploi du Chlorure de Calcium pour la Dessiccation du Vent des Hauts Fourneaux, procédé Daubiné et Roy). Detailed description of the

process. Ills. Serial. 1st part. 2400 w. Génie Civil—Jan. 15, 1910. No. 11737 D.

**Electrometallurgy.**

The Electrical Reduction of Iron Ore. Joseph W. Richards. Describes the work of several investigators in the development and operation of this method of manufacturing pig iron on a practical commercial scale. 2500 w. Jour Fr Inst—Feb., 1910. No. 12018 D.

A New Electric Process for Producing and Refining Steel with Composite Arc Electrodes. Frank C. Perkins. Drawings of electrodes used, and description of the process. 2200 w. Can Min Jour—Feb. 1, 1910. No. 11471.

The Phenomenon of Decantation in the Electric Furnace (Phénomène de Décantation au Four électrique). Ch. Clausel de Coussergues. A discussion of the phenomena of oxidation and purification in the electric steel furnace. 2300 w. Rev de Métal—Jan., 1910. No. 11707 E + F.

**Ferro-Alloys.**

Ferro-Silicon. Information from a report of an investigation of the nature, uses, and manufacture of ferro-silicon, on account of the deaths and illnesses arising among the crews and passengers on boats carrying the material. 2500 w. Engr, Lond—Feb. 11, 1910. No. 11842 A.

**France.**

Iron and Coal in French Lorraine (Eisenerz und Kohle in Französisch-Lothringen). Herr Krecke. Brief description of the deposits. Ills. 3500 w. Glückauf—Jan. 8, 1910. No. 11761 D.

**New Jersey.**

Contributions to the Mineralogy of Franklin Furnace, N. J. Charles Palache. Gives results obtained in a study, continued through several years, of the minerals of this locality. 2500 w. Am Jour of Sci—Feb., 1910. No. 11820 D.

**New York.**

The Iron Ores of New York State. S. Norton. Synopsis of an address before the Soc. of Engrs. of Eastern New York. Illustrated article giving a general survey of the various districts and the character of the deposits. 3500 w. Ir Age—Feb. 17, 1910. No. 11629.

**Ontario.**

Iron Ranges of Northern and Northwestern Ontario. Abstract of the 18th annual report of the Ontario Bureau of Mines for 1909. 3000 w. Eng & Min Jour—Feb. 12, 1910. No. 11579.

**Open Hearth.**

The Present Position of the Basic Open-Hearth Process. O. Petersen. Trans. from *Stahl und Eisen*. Considers the importance of the mixer, the Hoesch process, and other recent processes. 2500 w. Ir & Coal Trds Rev—Jan. 21, 1910. Serial. 1st part. No. 11401 A.

**Rolling Mills.**

The Design of Straightening Rolls for Tubes and Bar Iron (Die Formgebung der Schrägwalzen bei Richtmaschinen für Rohre und Rundstäbe). F. Mayer. Mathematical demonstration of method of determining the proper profile. Ills. 4000 w. Stahl u Eisen—Jan. 19, 1910. No. 11751 D.

See also Electric Hoisting, under MINING.

**Steel Refining.**

The Present Status of Steel-Refining Processes (Zum heutigen Stand des Herdfrischverfahrens). Otto Petersen. An exhaustive review of processes, apparatus, and plants. Ills. Serial. 1st part. 22500 w. Stahl u Eisen—Jan. 5, 1910. No. 11750 D.

**United States.**

Foreign Ore Deposits for Eastern Blast Furnaces. B. S. Stephenson. Reports results of attempts to find new sources of supply. 4000 w. Ir Trd Rev—Jan. 27, 1910. No. 11312.

## LEAD AND ZINC.

**British Columbia.**

St. Eugene Mine and Mill, East Kootenay, B. C. E. Jacobs. An account of Canada's most important lead-silver mine. 3500 w. Eng & Min Jour—Feb. 19, 1910. No. 11691.

**Mexico.**

Lead and Zinc Mining Industry of Mexico. H. B. Pulsifer. Describes the deposits, the treatment of the ores, etc. 1400 w. Min Wld—Jan. 29, 1910. No. 11321.

**Missouri.**

The Missouri-Kansas Lead-Zinc Industry. H. B. Pulsifer. An illustrated account of the district and its development. 3500 w. Min Wld—Feb. 12, 1910. No. 11575.

## MINOR MINERALS.

**Aluminium.**

The Aluminium Industry in France (L'Industrie de l'Aluminium en France). R. Pitaval. Discusses its manufacture, production and applications. Ills. 9300 w. Mem Soc Ing Civ de France—Nov., 1909. No. 11704 G.

**Barite.**

The Geology, Mining, and Preparation of Barite in Washington County, Missouri. A. A. Steel. A detailed description of the local geology, discussing the origin of the barite; describes the methods of mining, and preparation for the market. Map and plans. 11500 w. Bul Am Inst of Min Engrs—Feb., 1910. No. 11983 F.

**Cement.**

The American Cement Industry and the Cement Products Exhibition. Ernest F. Burchard. A review of the industry and a description of features of the show at

Chicago. 6000 w. Mfrs' Rec—Feb. 24, 1910. No. 11870.

Recent Progress in the Cement, Lime, Phosphate and Potash Industries (Neuere Fortschritte in der Zement-, Kalk-, Phosphat- und Kaliindustrie). C. Naske. A review of recent inventions of apparatus and processes. Ills. Serial. 1st part. 5000 w. Zeitschr d Ver Deutscher Ing—Jan. 1, 1910. No. 11933 D.

See also Blast-Furnace Slag, under IRON AND STEEL.

**Clay Products.**

The Work of the Clay Products Section of the Technologic Branch, United States Geological Survey. A. V. Bleininger. An account of the work, especially the testing of various structural materials and of clays. Discussion. Ills. 1200 w. Pro Engrs' Soc of W Penn—Jan., 1910. No. 11965 D.

**Diamonds.**

Premier Diamond Mine, near Pretoria, Transvaal. E. M. Weston. Illustrated description of the largest diamond pipe in the world mined by hand. 2200 w. Eng & Min Jour—Feb. 12, 1910. No. 11581.

**Graphite.**

Graphite. Remarks on its qualities, formations in which it is found, and description of methods of preparation at Chester Springs, Pa. 2800 w. Mines & Min—Feb., 1910. No. 11439 C.

**Lime.**

See Cement, under MINOR MINERALS.

**Nickel.**

Expansion in Ontario's Nickel-Copper Fields (Canada). Alexander Gray. Discusses the Monel metal, and the importance of its development, and matters relating to the industry in Ontario. 3500 w. Min Jour—Jan. 29, 1910. No. 11532 A.

**Nitrate.**

The Nitrate Deposits of Chile. R. A. F. Penrose, Jr. Considers the location of the nitrate regions, giving an outline of the history of the nitrate mining industry, describing the deposits, discussing their origin, and the industrial features. Ills. 9000 w. Jour of Geol—Jan.-Feb., 1910. No. 11817 D.

**Oil.**

The New Russian (Maikop) Naphtha Area. E. de Hautpick. Maps and account of the oil deposits, the geology, development, etc. 1500 w. Min Jour—Feb. 5, 1910. Serial. 1st part. No. 11605 A.

**Phosphate.**

See Cement, under MINOR MINERALS.

**Potash.**

See Cement, under MINOR MINERALS.

**Talc.**

Talc Mines and Industry of North Carolina. Claud Hafer. Describes the deposits and their development. Ills. 1000 w. Min Wld—Feb. 12, 1910. No. 11577.

**Tin.**

Tin Mining and Ore Dressing in South Africa. E. M. Weston. Describes the geology of the tinfields, and the three classes of bedded deposits of tin ore, the sluicing methods and hand jigging employed. Ills. 2000 w. Eng & Min Jour—Feb. 19, 1910. Serial. 1st part. No. 11688.

Electrolytic Precipitation of Tin (Beitrag zur elektrolytischen Schnellfällung des Zinns). B. Pasztor. Gives results of an investigation of electrolytic methods of tin assaying. 2100 w. Elektrochem Zeitschr—Jan., 1910. No. 11748 D.

Progress and Innovations in Tin Metallurgy During 1908 (Fortschritte und Neuerungen in der Metallurgie des Zinns im Jahre 1908). H. Mennicke. The first part gives a review of patents and a bibliography. Serial. 1st part. 2500 w. Elektrochem Zeitschr—Jan., 1910. No. 11749 D.

## MINING.

**Air Compressors.**

See same title, under MECHANICAL ENGINEERING, POWER AND TRANSMISSION.

**Caving System.**

Caving System in Ely District. Frank Kennedy. Plans and description of method of mining. 1200 w. Wis Engr—Feb., 1910. No. 12008 D.

**Drilling.**

Modern Rock Drilling. Discusses the relative advantages of piston and hammer drills, reporting tests in South Africa. Ills. 2500 w. Mines & Min—Feb., 1910. No. 11438 C.

**Earth Settlement.**

Injuries to Buildings Located Over Mines (Angebliche Bergschäden und ihre wirklichen Ursachen). Herr Schwidtal. Discusses proper construction. 3000 w. Glückauf—Jan. 29, 1910. No. 11766 D.

**Electric Hoisting.**

A Comparison of the Power Fluctuations of Electric Hoists and Reversing Rolls (Ausgleich der Kraftschwankungen von elektrisch angetriebenen Hauptschachtfördermaschinen und Reversierwalzenstrassen). F. Niethammer. Ills. 2500 w. Elek Kraft u Bahnen—Jan. 14, 1910. No. 11915 D.

**Electric Power.**

Electrical Safety System for Use in Mines. H. J. Fisher. Explains the system devised by the author which reduces risk of shock. Ills. 2800 w. Elec Engr, Lond—Feb. 11, 1910. No. 11829 A.

**Explosives.**

Practical Hints on the Use of Explosives. Matt. W. Alderson. On the safe handling of explosives, giving examples of dangerous practices. 2000 w. Min Wld—Feb. 12, 1910. No. 11576.

See also same title, under RAILWAY ENGINEERING, TRAFFIC.

**Haulage.**

Endless Rope Haulage. H. G. Kay. Notes on the system of hauling as practiced on diamond mining properties, where large quantities of ground are handled in open workings. 2000 w. Jour Chem, Met, & Min Soc of S Africa—Dec., 1909. No. 11597 E.

**Hoisting.**

Determining the Output of a Shaft with a Cylindrical Winding Drum. A. W. Brown. Abstract of a paper read before the Manchester Geol. Soc. Diagrams and explanation of an empirical method of determining the maximum output of a vertical shaft, using a cylindrical winder, under stated conditions. 4000 w. Ir & Coal Trds Rev—Feb. 4, 1910. No. 11624 A.

Wire Ropes in Colliery Practice. R. H. Rowland. Illustrates and describes various arrangements of pulleys and discusses the benefits conferred by lubricating both winding and hauling ropes. 2500 w. Eng & Min Jour—Jan. 29, 1910. No. 11330.

**Law.**

A Topical Digest of the Mexican Mining Law Recently Enacted by the Mexican Congress, and Effective Jan. 1, 1910. Shows important changes in the penal provisions, but the status of aliens is unchanged. 4500 w. Eng & Min Jour—Feb. 19, 1910. No. 11690.

**Mine Cars.**

A Composite Mine Car. William Archie Weldin. Illustrated description of a mine car of wood and steel, discussing the advantages and disadvantages. 3000 w. Mines & Min—Feb., 1910. No. 11441 C.

**Mine Locomotives.**

A New Internal Combustion Locomotive. Illustrates and describes a new English mining locomotive with oil engine, for underground haulage. 600 w. Engr, Lond—Jan. 2, 1910. No. 11400 A.

**Pumping.**

Water Columns for Deep Level Mines. E. J. Laschinger. Formulates expressions giving the average cost of water columns for depths up to 2000 ft. vertical, in terms of the diameter, and also the cost of h.p. lost by friction. 1200 w. Ap Sci—Jan., 1910. No. 11828 C.

**Shafts.**

The "Walker" System of Concrete Lining for Pit Shafts. Illustrated description of a new system of lining pit shafts with concrete blocks at Tryddyn, North Wales. Plate. 3000 w. Ir & Coal Trds Rev—Feb. 11, 1910. No. 11859 A.

Shaft Tubbing (Ueber die Verstärkung der Tübbings durch geeignete Formgebung). Herr Heise. Discusses the form of tubbing to give greatest strength in shaft lining. Ills. 2000 w. Glückauf—Jan. 22, 1910. No. 11764 D.

**Shaft Sinking.**

Improved Shaft-Sinking Methods at Ducktown. William Young Westervelt. Describes interesting work in Tennessee. Plan. 800 w. Eng & Min Jour—Jan. 29, 1910. No. 11329.

**Stowing.**

Sand Dumping Bridges for the Waste Stowing Plant of the Upper Silesia Coal Mines (Sandabsturzbrücken für den Spülversatz der oberschlesischen Kohlenbergwerke). Karl Bernhard. Describes a bridge over a waste-storage plant on which cars of sand are dumped. Ills. 2500 w. Zeitschr d Ver Deutscher Ing—Jan. 8, 1910. No. 11937 D.

**Timbering.**

Economics in the Use of Steel in Mine Timbering. R. B. Woodworth. Abstract of paper read before the W. Va. Coal Min. Inst. Calls attention to advantages and points out considerations necessary for its successful use. 3000 w Min Wld—Feb. 5, 1910. No. 11494.

Armored Concrete in Mines. Illustrates and describes armored concrete washery bunkers erected in South Wales and other places; and also shaft work and incline and platform work in France; viaducts, etc. 1200 w. Engr, Lond—Jan. 21, 1910. No. 11399 A.

**Unwatering.**

Unwatering the Mexiamora Mine at Guanajuato. F. H. Clark. An account of many attempts that failed and the final success. 1600 w. Eng & Min Jour—Jan. 29, 1910. No. 11328.

**Wire Rope.**

Method of Splicing Wire and Other Ropes. J. Watt. Illustrated detailed instructions for making and tapering long, short, and eye splices. 1400 w. Eng & Min Jour—Feb. 19, 1910. No. 11689.

## ORE DRESSING AND CONCENTRATION.

**Classification.**

The Keedy Sizer for Classifying Complex Ores. Carl F. Dietz and Dyke V. Keedy. Shows the importance of sizing, and describes a machine which aims to separate accurately at low power and maintenance cost. 5000 w. Eng & Min Jour—Feb. 5, 1910. No. 11475.

**Drying.**

The Efficiency of Heat Dryers. W. B. Ruggles. Brief illustrated description of apparatus for drying granular materials. 700 w. Cassier's Mag—Feb., 1910. No. 11671 B.

Recent Processes and Apparatus for Coal Drying (Neuere Verfahren und Einrichtungen auf dem Gebiete der Kohletrocknung). Herr Jordan. Illustrated description of a number of devices. 4500 w. Glückauf—Jan. 15, 1910. No. 11763 D.

**Gold Milling.**

Recent Milling Practice. A. E. Druck-

*We supply copies of these articles. See page 158.*

er. A short description of recent important changes in Korea, Philippines, and India. 2000 w. Min & Sci Pr—Feb. 19, 1910. No. 11889.

Equipment and Practice at Florence-Goldfield Mill. H. G. Morris. Illustrates and describes the mill and its equipment, criticizing the arrangement of batteries, and other features of the practice. 1200 w. Eng & Min Jour—Feb. 12, 1910. No. 11580.

**Lead Milling.**

See British Columbia, under LEAD AND ZINC.

**Tin.**

See same title, under MINOR MINERALS.

### MISCELLANY.

**Brazil.**

The Mineral Wealth of the State of Bahia, Brazil. A. J. de Sousa Carneiro. A report of the mineral deposits found, including diamonds, and other gems, gold, silver, copper, and many minerals of value. 2500 w. Min Jour—Feb. 12, 1910. No. 11839 A.

**Igneous Rocks.**

Igneous Rocks: Their Classification in the Field. Gordon Surr. Considers briefly the more important mineral bearing rocks, the texture of igneous rocks, volcanic glasses, etc. 8500 w. Min Wld—Feb. 5, 1910. No. 11492.

**Japan.**

Mining in Japan (Der Bergbau Japans). W. Paul. A review of the mining industry. 6500 w. Glückauf—Jan. 22, 1910. No. 11765 D.

**Korea.**

The Economic Ore Deposits of Korea (Die nutzbaren Lagerstätten Koreas). A brief review of Korea's mineral resources. Serial. 1st part. 2000 w. Oest Zeitschr f Berg u Hüttenwesen—Jan. 22, 1910. No. 11759 D.

**Nova Scotia.**

Nova Scotia's Mineral Output in 1909. Arthur S. Barnstead. A review of the mining industry, production, etc. 2500 w. Can Min Jour—Feb. 1, 1910. No. 11470.

**Ore Deposits.**

The Genesis of the Leadville Ore-Deposits. Max Boehmer. Explains their origin as shown by recent developments. 1200 w. Bul Am Inst of Min Engrs—Feb., 1910. No. 11984 F.

**Refractory Materials.**

Refractories in Furnace Construction. Notes from a treatise recently issued by the Harbison-Walker Refractories Co., Pittsburgh, Pa., giving a summary of the principal refractories used, especially in open-hearth furnace bottoms. 1000 w. Met & Chem Engng—Feb., 1910. No. 11432 C.

**Yukon.**

Condition and Needs of Mining in the Yukon. F. T. Congdon. Extracts from a speech describing conditions in the Yukon, explaining the causes of the reduction of revenue and discussing the policy of the Canadian government. 3800 w. Can Min Jour—Feb. 1, 1910. No. 11469.

## RAILWAY ENGINEERING.

### CONDUCTING TRANSPORTATION.

**Color Blindness.**

Colour-Blindness. F. W. Eldridge-Green. The author explains the theory adopted in order to explain vision and colour-vision, discussing the practical side of the subject. General discussion. 8800 w. Jour Soc of Arts—Feb. 11, 1910. No. 11860 A.

**Signaling.**

Drafting Room Practice in the Signal Department. Albert G. Moore. Outlining the signal drafting methods adopted by the Illinois Central. 2000 w. Ills. Sig Engr—Feb., 1910. No. 11696.

Signaling and Interlocking on the Victorian Railways. F. M. Calcutt. An illustrated résumé of standard practice. 900 w. Sig Engr—Feb., 1910. No. 11695.

The World System of Railway Signals. Illustrated description of the method of illuminating the background of this signal. 800 w. Ry & Loc Engng—Feb., 1910. No. 11450 C.

Railway Signals. Critical letter on the signal systems in use. 2000 w. Ry & Loc Engng—Feb., 1910. No. 11449 C.

### MOTIVE POWER AND EQUIPMENT.

**Air Brakes.**

Brake Manipulation and Operation in General Freight Service, with a Review of Some of the Causes and Conditions Which Produce Shocks and Break-in-Twos. W. V. Turner. Ills. 16500 w. Pro W Ry Club—Dec. 21, 1909. No. 12020 C.

K. Triple Valve Tests. Gives tabulated results of tests with remarks. 800 w. Ry & Loc Engng—Feb., 1910. No. 11452 C.

Air Brake Study. Suggestions for study of air brakes. 1200 w. Ry & Loc Engng—Feb., 1910. No. 11453 C.

**Car Disinfection.**

The Disinfection of Passenger Cars in Shops (Die Desinfektion der Eisenbahn-Personenwagen in den Werkstätten). Herr Schumacher. Detailed description of a disinfecting plant in Potsdam. Ills.

*We supply copies of these articles. See page 158.*

3000 w. Glaser's Ann—Jan. 15, 1910. No. 11790 D.

**Electrification.**

The Electrification of Trunk Lines. L. R. Pomeroy. Discusses the commercial considerations relating to this question. 5000 w. Jour Am Soc of Mech Engrs—Feb., 1910. No. 11986 F.

The Electrification of Trunk Lines. L. R. Pomeroy. The basis of an address recently given before the Engng. Soc. of Columbia Univ., N. Y. A discussion of the problem of electrification. 5000 w. Am Engr & R R Jour—Feb., 1910. No. 11487 C.

The Electrification of Trunk Lines. L. R. Pomeroy. Abstract of an address before the Engng. Soc. of Columbia Univ. Gives a survey of the present situation, with conclusions. 4000 w. Ry Age Gaz—Feb. 18, 1910. No. 11663.

See also Track Maintenance, under STREET AND ELECTRIC RAILWAYS.

**Freight Cars.**

Steel Box Car for the Union Pacific. Illustrated description of a car built at the Omaha shops. 200 w. Ry Age Gaz—Feb. 11, 1910. No. 11562.

Hopper-Ballast Wagons on the Queensland Railways. Illustrates and describes the older and more recent forms of hopper-wagons used. 300 w. Engng—Jan. 28, 1910. No. 11537 A.

**Locomotive Boilers.**

The Locomotive Boiler from a Purely Practical Point of View. Leslie McLaren. Observations from the engineman's point of view, especially with regard to the smoke nuisance and the emission of sparks. Ills. 1500 w. Boiler Maker—Feb., 1910. No. 11505.

Locomotive Boiler Inspection. Garland P. Robinson. From the third annual report, N. Y. Pub. Service Com. 1600 w. Boiler Maker—Feb., 1910. No. 11504.

Pennsylvania Railroad Specifications for Steel Boiler Tubes and Safe Ends. Gives specifications covering cold and hot-drawn and lap-welded steel tubes and safe ends. 1200 w. Ry Age Gaz—Feb. 4, 1910. No. 11462.

**Locomotive Power.**

The Tractive Power of Locomotives. William N. Allman. Discusses the calculation of tractive power. 2000 w. Ry Age Gaz—Feb. 11, 1910. No. 11563.

The Tractive Power of Simple and Compound Locomotives. Sidney C. Carpenter. Gives diagrams, showing a close approximation of the tractive power without calculation, and examples illustrating their use. 500 w. Ry Age Gaz—Jan. 28, 1910. No. 11302.

**Locomotives.**

Simple 4-6-2 and 2-8-0 for the Chicago & North-Western. Illustrated description of a Pacific type engine, and a consolidation type. 1200 w. Ry & Loc Engng—Feb., 1910. No. 11455 C.

New Consolidation Locomotive of the Lehigh Valley R. R. Illustrated description of an interesting engine showing unusual details. 700 w. Ry & Engng Rev—Feb. 12, 1910. No. 11558.

Heavy Consolidation Locomotive. Illustrated description of heavy consolidation locomotive, class H8b for the Pennsylvania Railroad. 1500 w. Am Engr & R R Jour—Feb., 1910. No. 11490 C.

Ten-Wheel Passenger Locomotive, with Emerson Superheater, and Consolidation Locomotive. Illustrated description of engines for the Chicago, Great Western Railway. 900 w. Am Engr & R R Jour—Feb., 1910. No. 11489 C.

Baldwin 4-4-2 for the Idaho & Washington Northern. Illustrated detailed description of a simple engine using moderately superheated steam. 800 w. Ry & Loc Engng—Feb., 1910. No. 11448 C.

Notes on Great Western Express Locomotives and Their Work. Reports the work of 4-6-0 four-cylinder, non-compound locomotives. 5000 w. Engr, Lond—Feb. 11, 1910. No. 11847 A.

Eight-Wheel Engines with Superheaters for the Western Railway of Havana. Illustrated description of engines equipped with the builders' latest design of fire-tube superheater with side headers. 900 w. Ry Age Gaz—Feb. 25, 1910. No. 11953.

Mallet Compound Locomotive for the Central South African Railways. Illustrated description of an articulated compound for a narrow gage road. 900 w. Ry & Engng Rev—Feb. 19, 1910. No. 11861.

Mallet Articulated Compound Locomotive for the Colombia National. Illustrated detailed description of engines to be operated on a track of 3-ft. gage, laid with 45-lb. rails. 1200 w. Ry Age Gaz—Feb. 18, 1910. No. 11664.

New Pacific Type Express Engines for the P. L. M. Railway Company. Illustrations and dimensions of new compound and non-compound engines for this French railway. 200 w. Engr, Lond—Jan. 28, 1910. No. 11543 A.

Recent Light-Railway Locomotives (Neuerungen im Bau von Kleinbahnlokomotiven). A. Doeppner. Describes types recently produced in Europe. Ills. 4500 w. Mit d Ver f d Förd d Lokal- u Strassenbahnwesens — Jan., 1910. No. 11747 F.

Garratt Compound, Truck-Drive Locomotive for the Tasmanian State Railways (Locomotive compound à Bogies moteurs et à Chaudière indépendante, système Garratt, des Chemins de Fer de l'Etat de Tasmanie). Illustrated description. 1500 w. Génie Civil—Jan. 8, 1910. No. 11732 D.

**Locomotive Superheaters.**

Flue Type Superheaters for Locomotives. Illustrates and describes an improved superheater, designed by G. T. Churchward. 1500 w. Prac Engr—Jan. 21, 1910. No. 11378 A.

**Locomotive Tests.**

Results of the Test Runs with the 4/5 Coupled Compound Freight Locomotives, Group 730, of the Italian State Railways (Ergebnisse der Versuchsfahrten mit der 4/5-gekuppelten Verbund - Güterzuglokomotive Gruppe 730 der Italienischen Staatsbahnen). G. Heise. Describes the locomotive and tests and gives detailed results. Ills. 4200 w. Zeitschr d Ver Deutscher Ing—Jan. 22, 1910. No. 11942 D.

**Motor Cars.**

Motive Power of Motive Cars. Francis W. Lane. An illustrated description of what has been accomplished in steam cars and gasoline cars. 3500 w. Ry Mas Mech—Feb., 1910. No. 11565.

**Shops.**

New Shops of Central Georgia at Macon, Ga. Illustrated detailed description of the completed shops of a new plant under construction. 5500 w. Ry Age Gaz—Feb. 4, 1910. No. 11460.

Tool Lay-Out for the Scranton Shops of the Delaware, Lackawanna & Western. George L. Fowler. The arrangement and grouping of the tools on the floor of the shop is described and plans given. 3500 w. Ry Age Gaz—Feb. 4, 1910. No. 11461.

Finishing Locomotive Driving Wheels and Axles. Editorial on present practice on driving wheel work in repair shops. 2000 w. Ry Age Gaz—Feb. 4, 1910. No. 11458.

See also Roundhouses, under PERMANENT WAY AND BUILDINGS.

**Springs.**

A Study of the Springs Employed in the Construction of Railway Cars (Etude des Ressorts employés dans les Véhicules de Chemins de Fer). P. Piérart. The first part discusses laminated springs, their design, construction, incorporation in car construction, etc. Ills. Serial. 1st part. 2000 w. Tech Mod—Jan., 1910. No. 11716 D.

**Train Ferries.**

See Ferry Steamers, under MARINE AND NAVAL ENGINEERING.

**Wheel Contacts.**

Area of Contact Between Car Wheels and Rails. E. L. Hancock. An illustrated account of experimental work to determine the area of contact. 2200 w. Eng News—Feb. 10, 1910. No. 11516.

## PERMANENT WAY AND BUILDINGS.

**Construction.**

Some Notes on Specifications for Earthwork in Railway Construction. Notes prepared by James H. Bacon touching upon questions of classification and overhaul in an interesting manner. 1200 w. Engng-Con—Feb. 23, 1910. No. 11872.

**Elevated Railways.**

Track Elevation at Evanston, Ill., Chicago, Milwaukee & St. Paul Ry. E. O. Greifenhagen. Describes interesting construction work in connection with grade separation. Ills. 9500 w. Eng News—Feb. 10, 1910. No. 11517.

See also Stations, under PERMANENT WAY AND BUILDINGS.

**Grade Reduction.**

Colfax Grade Revision; Southern Pacific. Bradford Boardman. Illustrated detailed account of a low-grade line under construction in California. 4500 w. Ry Age Gaz—Feb. 18, 1910. No. 11662.

**Location.**

Railroad Location. W. G. Swan. A detailed account of preliminary work, outfitting, methods of work, survey and final location. Ills. 5000 w. Ap Sci—Jan., 1910. No. 11826 C.

**Narrow Gauge.**

The Cochin Forest Railway. Edward Harran. Illustrated description of a tramway line on the meter gage in South India, for working valuable forests on scientific principles. 1200 w. Sci Am—Feb. 26, 1910. No. 11883.

**Reconstruction.**

Harlem River Branch Improvements, New York, New Haven & Hartford. Illustrates and describes the making this branch a six-track line, and the abolishing of all grade crossings. Eventually it will be electrified. 600 w. Ry Age Gaz—Jan. 28, 1910. Serial. 1st part. No. 11304.

**Roundhouses.**

The New Shops of the Austrian State Railways at Attnang-Puchheim (Die neue Zugförderungsanlage in der Station Attnang-Puchheim der k. k. österr. Staatsbahnen). Edward Popper. Describes the roundhouse, turntable, shop, coaling and water towers, etc. Ills. 4500 w. Oest Wochenschr f d Oeffent Baudienst—Jan. 15, 1910. No. 11901 D.

**Stations.**

The Design of the Stations on the Evanston, Ill., Track Elevation work; C., M. & St. P. Ry. E. O. Greifenhagen. Explains reasons for the location and designs adopted, describing the general features. Ills. 3000 w. Eng News—Feb. 17, 1910. No. 11646.

See also Reinforced Concrete, under CIVIL ENGINEERING, CONSTRUCTION.

**Surveying.**

The Transcontinental Railway Survey of Australia. Discusses the recently completed 1070-mile survey for a proposed line to connect the State of Western Australia with the four other States. 1500 w. Engr, Lond—Feb. 4, 1910. No. 11621 A.

*We supply copies of these articles. See page 158.*

**Switches.**

The Facing Point-Lock. W. H. Arkenburgh. Describes an improved arrangement for mechanically interlocked switches explaining its advantages. 2000 w. Ry Age Gaz—March 4, 1910. No. 12126.

**Terminals.**

Proposed Rearrangement of Railway Terminals in Chicago. Describes a plan for the entire rearrangement of the railway passenger terminals and the establishment of a large union station. Also editorial. 1400 w. Eng News—Feb. 24, 1910. No. 11879.

**Ties.**

Concrete Ties for Railroads. Illustrates and describes types. 1000 w. Ry & Loc Engng—March, 1910. No. 12116 C.

A Combination Steel and Concrete Tie on the Pittsburg, Fort Wayne & Chicago Ry. Illustrated description of the Riegler tie in experimental use. 600 w. Eng News—Feb. 17, 1910. No. 11649.

Two Foreign Developments in Railway Ties. Describes two recent developments, one of concrete ties made in vibrating molds; the other a compound tie of wood and steel. Ills. 1000 w. Eng News—Feb. 17, 1910. No. 11648.

See also Timber Preservation, under CIVIL ENGINEERING, MATERIALS OF CONSTRUCTION.

**Track Construction.**

Track on German Railways. Notes from a paper by Mr. Blum describing German practice, with observations by W. C. Cushing. Ills. 3000 w. Eng Rec—Jan. 29, 1910. No. 11316.

**Track Maintenance.**

The American Railway Engineering and Maintenance of Way Association. W. D. Pence. A brief account of the work and of the history of the association. 2000 w. Wis Engr—Feb., 1910. No. 12010 D.

**Tunnels.**

The Reduction of Ruling Grade in Mountain Railway Tunnels (Die Verminderung der Höchsteigung in Tunneln der Gebirgsbahnen). R. Sanzin. Discusses the reduction in tractive power in long tunnels and the necessity of reducing grades. 3200 w. Zeitschr d Ver Deutscher Ing—Jan. 29, 1910. No. 11946 D.

## TRAFFIC.

**Car Interchange.**

Freight Car Interchange Inspection. Jno. J. O'Brien. Discusses the conditions under which cars are interchanged, some special arrangements between lines, rules, and related matters. 7800 w. Pro St Louis Ry Club—Jan. 14, 1910. No. 11815.

Car Interchange Past, Present, and Future. W. O. Thompson, with discussion. A short paper introductory to a lengthy discussion. 14500 w. Pro Cent Ry Club—Jan. 13, 1910. No. 11812 C.

**Explosives.**

The Testing of Explosives for Sensitiveness to Shock by the Drophammer Method. Dr. H. Kast. Trans. from *Zeit für das gesamte Schiess- und Sprengstoffwesen.* States the conditions to be complied with, and describes the apparatus used in the Military Experimental Bureau for testing sensitiveness. 1500 w. Jour Fr Inst—Feb., 1910. No. 12019 D.

**Freight.**

Fast Freight Lines. G. G. Huebner. Considers the through service prior to their organization and present day freight lines. 3500 w. Ry Age Gaz—Feb. 11, 1910. No. 11564.

Bulk Freight Traffic (Beförderungswege für Massengüter). Herr Cauer. Refers to conditions in Germany. Discusses freight rates, rail and water traffic, etc. Discussion. 13000 w. Glasers Ann—Jan. 1, 1910. No. 11789 D.

**Freight Handling.**

Mechanical Handling of Freight at Transfer Stations. H. McL. Harding. Illustrated description of a typical transfer station at Toledo, Ohio. 4500 w. Ry & Engng Rev—Feb. 12, 1910. No. 11557.

## MISCELLANY.

**Accounting.**

Equipment Depreciation and Renewal. William Mahl. Gives statements showing the number of locomotives and cars vacated in each of eight years, the amount credited to the replacement fund, the amount charged to operating expense and the amount of salvage, with discussion of the data. 2000 w. Ry Age Gaz—March 4, 1910. No. 12124.

**Austria-Hungary.**

The Railways of Austria and Hungary. Editorial on the conditions under which the railways are managed as based on information in a recent report to the Board of Trade. 2500 w. Engng—Feb. 11, 1910. No. 11856 A.

**Belgium.**

Lines of Local Interest in Belgium (Die belgischen Vizinalbahnen). A. E. Ziffer. Outlines their development and discusses their economic importance. 10000 w. Mit d Ver f d Förd d Lokal- u Strassenbahnwesens—Jan., 1910. No. 11746 F.

**Central America.**

See South America, under MISCELLANY.

**Education.**

See same title, under INDUSTRIAL ECONOMY.

**France.**

The Purchase of the Lines of the Western Railway of France (Le Rachat du Réseau des Chemins de Fer de l'Ouest). P. Maurice. Discusses the terms of the purchase of this railway by the French Government. 4700 w. Génie Civil—Jan. 1, 1910. No. 11731 D.

*We supply copies of these articles. See page 158.*

**German East Africa.**

Our Railways in Togo (Unsre Eisenbahnen in Togo). Carl Mosig. Describes existing and projected lines, rolling stock, etc. Ills. 6300 w. Zeitschr d Ver Deutscher Ing—Jan. 1, 1910. No. 11935 D.

**Government Control.**

Government Regulation of Railway Corporations. Emory R. Johnson. From an address before the Economic Club of N. Y. Discusses the legislation proposed by the President. 3000 w. Ry Age Gaz—Feb. 11, 1910. No. 11561.

**Government Ownership.**

See France, under MISCELLANY.

**Management.**

Railroad Administration. Albert J. Himes. Calls attention to some of the features deserving first attention by the beginner. 4000 w. Cornell Civ Engr—Feb., 1910. No. 12004 C.

The Unit System of Organization. Charles Hine, with discussion. Explains the details of the unit system of organization that is being installed on the Harriman lines, showing what has been accomplished. General discussion follows. 11000 w. Pro W Ry Club—Jan. 18, 1910. No. 11813 C.

The Organization of the Mechanical Department, New York, New Haven & Hartford. George L. Fowler. Gives an analysis of the organization, explaining methods followed to provide direct communication between every shop and the mechanical superintendent. 10000 w. Ry Age Gaz—March 4, 1910. No. 12129.

The Division Superintendent's Office and the Superintendency. C. A. Candee. Considers the reports, files, agreements, records, and other work of the clerical department. 4500 w. Ry Age Gaz—Feb. 11, 1910. No. 11559.

**Panama.**

The New Panama Railroad. R. F. Hoffmark. From the *Purdue Engng. Rev.* Explains the reasons why relocation was necessary and describes the line. 2500 w. Ry Age Gaz—Feb. 11, 1910. No. 11560.

**Reports.**

Making a Railway Report. Charles F. Speare. Suggestions for such reports and the features that all reports should contain. 2200 w. Ry Age Gaz—Feb. 25, 1910. No. 11898.

**Russia.**

Russian Railways in Asia (Russlands Eisenbahnen in Asien). A brief review of the railways financed and controlled by Russia. Ills. 2500 w. Oest Wochenschr f d Oeffent Baudienst—Jan. 1, 1910. No. 11799 D.

**South America.**

Railways in Central and South America. Explains the reasons for the lack of through routes, and gives information from a recent bulletin of the International Bureau of American Republics. Maps. 3000 w. Ry Age Gaz—Feb. 25, 1910. No. 11899.

**Valuation.**

Valuation of Railways in Washington. J. C. Lawrence. Explains methods used to determine the value, the determination of the reasonableness of rates, and the conclusions. 5000 w. Ry Age Gaz—Feb. 18, 1910. No 11665.

Valuation and Rate Regulation. Editorial discussing the conclusion of the Washington Railway Commission. 3500 w. Ry Age Gaz—March 4, 1910. No. 12123.

**Welfare Work.**

See same title, under INDUSTRIAL ECONOMY.

## STREET AND ELECTRIC RAILWAYS.

**Accounting.**

The Electric Railway Auditor, His Duties and Relation to the Organization. W. B. Brockway. Read before the Am. St. & Int. Ry. Acc. Assn. Discusses the duties and requirements of the head of the accounting department, his responsibilities, etc. 3500 w. Jour of Acc—Feb., 1910. No. 11816 C.

**Austria.**

The Trient-Malé Electric Railway and the Trient Electric Power Stations (Die elektrische Lokalbahn Trient-Malé und die neuen Elektrizitätswerksanlagen der Stadtgemeinde Trient). Paul Dittes. Illustrated detailed description of this line in the Austrian Tyrol. Serial. 1st part. 4500 w. Zeitschr d Oest Ing u Arch Ver—Jan. 28, 1910. No. 11797 D.

**Car Inspection.**

Daily Inspection and Up-Keep of Rolling Stock. H. H. Buckman. Abstract of a paper read before the Cent. Elec. Ry. Assn., Columbus, O. Discusses important items in the up-keep of equipment. 3000 w. Elec Ry Jour—Jan. 29, 1910. No. 11311.

**Cars.**

New Pay-as-You-Enter Cars for the Public Service Railway, Newark, N. J. Illustrated detailed description. 1200 w. Elec Ry Jour—Feb. 12, 1910. No. 11578.

Trailer Motor Cars in Philadelphia. Illustrates and describes the rebuilt single-

*We supply copies of these articles. See page 158.*

truck open trail cars and their equipment. 1200 w. Elec Ry Jour—Feb. 26, 1910. No. 11892.

A New Storage-Battery Street Car. Illustrated description of the car to be tested in New York, equipped with the latest form of the Edison storage battery. 1200 w. Sci Am—Feb. 5, 1910. No. 11403.

**Controllers.**

New York Subway Control. W. B. Kouwenhoven. Considers the duties of the motorman in operating the equipment and in remedying troubles that may arise. 2500 w. Ry & Loc Engng—Feb., 1910. No. 11454 C.

**Electric Traction.**

The Future of Electric Traction on Railways. Philip Dawson. Discusses briefly the continuous-current and the single-phase systems. 2000 w. Elec Rev, Lond—Feb. 18, 1910. No. 12051 A.

Electric Traction on City and Suburban Railways. H. M. Hobart. A lecture at the School of Military Engng., Chatham. Discusses the advantages of electric traction which have led to its extensive use in a wide field of railway work. 4000 w. Tram & Ry Wld—Feb. 10, 1910. No. 11887 B.

A General Method of Dealing with Traction Problems in Railway Operation (Allgemeines und umkehrbares bildliches Staffelverfahren zur wechselseitigen Ermittlung sämtlicher Zugförderungsgrössen im Bahnbetriebe). Artur Hruschka. Mathematical discussion of the influence of the various factors. Ills. Serial. 1st part. 3000 w. Elek Kraft u Bahnen—Jan. 14, 1910. No. 11916 D.

**Instruction Cars.**

Re-Equipped Elevated Instruction Car of the Brooklyn Rapid Transit System. Illustrated detailed description. 1200 w. Elec Ry Jour—Feb. 5, 1910. No. 11443.

**Interurban.**

Lewiston, Augusta & Waterville Street Railway. Illustrated description of an interurban line in Maine, operating 140 miles of track. 5500 w. Elec Ry Jour—Jan. 29, 1910. No. 11310.

**Locomotives.**

New Electric Locomotives for the New Haven Railroad. N. W. Storer. Illustrated description of recently completed locomotives, tested with remarkable success. 1500 w. Elec Jour—Feb., 1910. No. 11999.

**Railless.**

Railless Electric Traction. R. Lonneman. Illustrated description of the electric trolley system without rails. 1500 w. Cassier's Mag—Feb., 1910. No. 11674 B.

Mercédès-Stoll Automobiles for Railless Electric Traction (Automobiles a Trolley aérien Système Mercédès Electrique Stoll). Illustrated description, with data of railless trolley lines in Austria. 1500 w. Génie Civil—Jan. 8, 1910. No. 11734 D.

**Single-Phase.**

The Padua-Fusina Single-Phase Line (Ferrovia a Trazione elettrica monofase Padova-Fusina). Describes briefly the line and equipment. Ills. 2500 w. Ing Ferro—Jan. 1, 1910. No. 11745 D.

**Stray Currents.**

Electrolysis by Earth Currents. William A. Del Mar. Explains the new conception of electrolysis which is a reversal of the views usually held. 3000 w. Elec Wld—Feb. 17, 1910. No. 11643.

**Subway Signaling.**

Signal System of the Hudson & Manhattan R. R. John Leisenring. Illustrated description of the signal system in the downtown tunnels. 1500 w. Sig Engr—Feb., 1910. Serial. 1st part. No. 11697.

**Switches.**

Electric Switch Operating Mechanism for Street Cars (Elektrische Weichenstellvorrichtung für Strassenbahnwagen). C. Werner. Describes devices produced by the Siemens-Schuckertwerke. Ills. 2500 w. Elek Kraft u Bahnen—Jan. 4, 1910. No. 11914 D.

**Switzerland.**

The Bellinzona-Mesocco 1500-Volt Railway. Illustrates and describes interesting features of this line. 1000 w. Elec Ry Jour—Feb. 19, 1910. No. 11657.

**Track Maintenance.**

The Effect of Electrical Operation on the Permanent-Way Maintenance of Railways. Charles Augustus Harrison. 2500 w. Elec Age—Jan., 1910. No. 11309.

**Trolley Lines.**

Notes on Tramway Overhead Equipment. H. Dudgeon. Notes on overhead work, considering the various strains encountered. 1500 w. Elec Rev, Lond—Jan. 28, 1910. Serial. 1st part. No. 11527 A.

The Experimental Catenary Line of the Connecticut Company. An illustrated account of an elaborate service test of catenary suspension systems on a line between Middletown and Hartford, Conn. 4000 w. Elec Ry Jour—Feb. 26, 1910. No. 11893.

Electric Traction on the New Boulevard Lille-Roubaix-Tourcoing (La Traction électrique sur le nouveau Boulevard Lille-Roubaix-Tourcoing). A. Bidault des Chaumes. Illustrated description of the line and its equipment. 4000 w. Génie Civil—Jan. 1, 1910. No. 11730 D.

**York, England.**

York Electric Tramways. An illustrated account of the electrification of the tramways, using the trolley system. 2500 w. Tram & Ry Wld—Feb. 10, 1910. No. 11886 B.

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## EXPLANATORY NOTE—THE ENGINEERING INDEX

We hold ourselves ready to supply—usually by return of post—the full text of every article indexed in the preceding pages, *in the original language*, together with all accompanying illustrations; and our charge in each case is regulated by the cost of a single copy of the journal in which the article is published. The price of each article is indicated by the letter following the number. When no letter appears, the price of the article is 20 cts. The letter A, B, or C denotes a price of 40 cts.; D, of 60 cts.; E, of 80 cts.; F, of $1.00; G, of $1.20; H, of $1.60. When the letter N is used it indicates that copies are not readily obtainable and that particulars as to price will be supplied on application. Certain journals, however, make large extra charges for back numbers. In such cases we may have to increase proportionately the normal charge given in the Index. In ordering, care should be taken to *give the number* of the article desired, not the title alone.

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## THE PUBLICATIONS REGULARLY REVIEWED AND INDEXED

The titles and addresses of the journals regularly reviewed are given here in full, but only abbreviated titles are used in the index. In the list below, *w* indicates a weekly publication, *b-w*, a bi-weekly, *s-w*, a semi-weekly, *m*, a monthly, *b-m*, a bi-monthly, *t-m*, a tri-monthly, *qr*, a quarterly, *s-q*, semi-quarterly, etc. Other abbreviations used in the index are: Ill—Illustrated; W—Words; Anon—Anonymous.

Alliance Industrielle. *m.* Brussels.
American Architect. *w.* New York.
Am. Engineer and R. R. Journal. *m.* New York.
American Jl. of Science. *m.* New Haven, U. S. A.
American Machinist. *w.* New York.
Anales de la Soc. Cien. Argentina. *m.* Buenos Aires.
Annales des Ponts et Chaussées. *m.* Paris.
Ann. d Soc. Ing. d Arch Ital. *s-m.* Rome.
Applied Science. *m.* Toronto, Ont.
Architect. *w.* London.
Architectural Record. *m.* New York.
Architectural Review. *s-q.* Boston.
Architect's and Builder's Magazine. *m.* New York.
Australian Mining Standard. *w.* Melbourne.
Autocar. *w.* Coventry, England.
Automobile. *w.* New York.
Automotor Journal. *w.* London.
Beton und Eisen. *qr.* Vienna.
Boiler Maker. *m.* New York.
Brass World. *m.* Bridgeport, Conn.
Builder. *w.* London.
Bull. Bur. of Standards. *qr.* Washington.
Bulletin de la Société d'Encouragement. *m.* Paris.
Bulletin du Lab. d'Essais. *m.* Paris.
Bulletin of Dept. of Labor. *b-m.* Washington.
Bull. of Can. Min. Inst. *qr.* Montreal.
Bull. Soc. Int. d'Electriciens. *m.* Paris.
Bulletin of the Univ. of Wis., Madison, U. S. A.
Bull. Int. Railway Congress. *m.* Brussels.
Bull. Scien. de l'Assn. des Elèves des Ecoles Spéc. *m.* Liége.
Bull. Tech. de la Suisse Romande. *s-m.* Lausanne.
California Jour. of Tech. *m.* Berkeley, Cal.
Canadian Architect. *m.* Toronto.
Canadian Electrical News. *m.* Toronto.
Canadian Engineer. *w.* Toronto and Montreal.
Canadian Mining Journal. *b-w.* Toronto.
Cassier's Magazine. *m.* New York and London.
Cement. *m.* New York.
Cement Age. *m.* New York.
Central Station. *m.* New York.
Chem. Met. Soc. of S. Africa. *m.* Johannesburg.
Clay Record. *s-m.* Chicago.
Colliery Guardian. *w.* London.
Compressed Air. *m.* New York.
Comptes Rendus de l' Acad. des Sciences. *w.* Paris.

Consular Reports. *m.* Washington.
Cornell Civil Engineer. *m.* Ithaca.
Deutsche Bauzeitung. *b-w.* Berlin.
Die Turbine. *s-m.* Berlin.
Domestic Engineering. *w.* Chicago.
Economic Geology. *m.* New Haven, Conn.
Electrical Age. *m.* New York.
Electrical Engineer. *m.* London.
Electrical Engineering. *w.* London.
Electrical Review. *w.* London.
Electrical Review. *w.* New York.
Electric Journal. *m.* Pittsburg, Pa.
Electric Railway Journal. *w.* New York.
Electrical World. *w.* New York.
Electrician. *w.* London.
Electricien. *w.* Paris.
Elektrische Kraftbetriebe u Bahnen. *w.* Munich.
Elektrochemische Zeitschrift. *m.* Berlin.
Elektrotechnik u Maschinenbau. *w.* Vienna.
Elektrotechnische Rundschau. *w.* Potsdam.
Elettricità. *w.* Milan.
Engineer. *w.* London.
Engineering. *w.* London.
Engineering-Contracting. *w.* New York.
Engineering Magazine. *m.* New York and London.
Engineering and Mining Journal. *w.* New York.
Engineering News. *w.* New York.
Engineering Record. *w.* New York.
Eng. Soc. of Western Penna. *m.* Pittsburg, U. S. A.
Foundry. *m.* Cleveland, U. S. A.
Génie Civil. *w.* Paris.
Giesserei-Zeitung. *s-m.* Berlin.
Glaser's Ann. f Gewerbe & Bauwesen. *s-m.* Berlin.
Heating and Ventilating Mag. *m.* New York.
Horseless Age. *w.* New York.
Ice and Cold Storage. *m.* London.
Ice and Refrigeration. *m.* New York.
Il Cemento. *s-m.* Milan.
Industrial Engineering. *m.* Pittsburg.
Industrial World. *w.* Pittsburg.
Ingegneria Ferroviaria. *s-m.* Rome.
Ingenieria. *b-m.* Buenos Ayres.
Ingenieur. *w.* Hague.
Insurance Engineering. *m.* New York.
Int. Marine Engineering. *m.* New York.
Iron Age. *w.* New York.
Iron and Coal Trades Review. *w.* London.
Iron Trade Review. *w.* Cleveland, U. S. A.
Jour. of Accountancy. *m.* N. Y.
Journal Asso. Eng. Societies. *m.* Philadelphia.
Journal Franklin Institute. *m.* Philadelphia.
Jour. Ind. & Engng. Chem. *m.* Easton, Pa.
Journal Royal Inst. of Brit. Arch. *s-q.* London.
Jour. Roy. United Service Inst. *m.* London.
Journal of Sanitary Institute. *qr.* London.
Jour. of South African Assn. of Engineers. *m.* Johannesburg, S. A.
Journal of the Society of Arts. *w.* London.
Jour. Transvaal Inst. of Mech. Engrs., Johannesburg, S. A.
Jour. of U. S. Artillery. *b-m.* Fort Monroe, U. S. A
Jour. W. of Scot. Iron & Steel Inst. *m.* Glasgow.
Journal Western Soc. of Eng. *b-m.* Chicago.
Jour. of Worcester Poly. Inst., Worcester, U. S. A.
Locomotive. *m.* Hartford, U. S. A.
Machinery. *m.* New York.
Manufacturer's Record. *w.* Baltimore.
Marine Review. *m.* Cleveland, U. S. A.
Mechanical Engineer. *w.* London.
Mechanical World. *w.* Manchester.
Mem. de la Soc. des Ing. Civils de France. *m.* Paris.
Metallurgical and Chem. Engng. *m.* New York.
Métallurgie. *w.* Paris.
Mines and Minerals. *m.* Scranton, U. S. A.
Mining and Sci. Press. *w.* San Francisco.
Mining Journal. *w.* London.
Mining World. *w.* Chicago.
Mittheilungen des Vereins für die Förderung des Local- und Strassenbahnwesens. *m.* Vienna.
Municipal Engineering. *m.* Indianapolis, U. S. A.
Municipal Journal and Engineer. *w.* New York.
Nautical Gazette. *w.* New York.
New Zealand Mines Record. *m.* Wellington.
Oest. Wochensch. f. d. Oeff. Baudienst. *w.* Vienna.
Oest. Zeitschr. Berg & Hüttenwesen. *w.* Vienna.
Plumber and Decorator. *m.* London.
Power and The Engineer. *w.* New York.
Practical Engineer. *w.* London.
Pro. Am. Ins. Electrical Eng. *m.* New York.
Pro. Am. Ins. of Mining Eng. *m.* New York.
Pro. Am. Soc. Civil Engineers. *m.* New York.
Pro. Am. Soc. Mech. Engineers. *m.* New York.
Pro. Canadian Soc. Civ. Engrs. *m.* Montreal.
Proceedings Engineers' Club. *qr.* Philadelphia.
Pro. Engrs. Soc. of Western Pennsylvania. *m.* Pittsburg.
Pro. St. Louis R'way Club. *m.* St. Louis, U. S. A.
Pro. U. S. Naval Inst. *qr.* Annapolis, Md.
Progressive Age. *s-m.* New York.
Public Works. *qr.* London.
Quarry. *m.* London.
Queensland Gov. Mining Jour. *m.* Brisbane, Australia.
Railway Age Gazette. *m.* New York.
Railway and Engineering Review. *w.* Chicago.
Railway and Loc. Engng. *m.* New York.
Railway Master Mechanic. *m.* Chicago.
Revista Tech. Ind. *m.* Barcelona.
Revue d'Electrochimie et d'Electrométallurgie. *m.* Paris.
Revue de Mécanique. *m.* Paris.
Revue de Métallurgie. *m.* Paris.
Revue Gén. des Chemins de Fer. *m.* Paris.
Revue Gén. des Sciences. *w.* Paris.
Revue Industrielle. *w.* Paris.
Rivista Marittima. *m.* Rome.
Schiffbau. *s-m.* Berlin.
School of Mines Quarterly. *q.* New York.
Schweizerische Bauzeitung. *w.* Zürich.
Scientific American. *w.* New York.
Scientific Am. Supplement. *w.* New York.
Sibley Jour. of Mech. Eng. *m.* Ithaca, N. Y.
Signal Engineer. *m.* Chicago.
Soc. Belge des Elect'ns. *m.* Brussels.
Stahl und Eisen. *w.* Düsseldorf.
Stevens Institute Indicator. *qr.* Hoboken, U. S. A.
Surveyor. *w.* London.
Technik und Wirtschaft. *m.* Berlin.
Technique Moderne. *m.* Paris.
Tramway & Railway World. *m.* London.
Trans. Inst. of Engrs. & Shipbuilders in Scotland, Glasgow.
Wood Craft. *m.* Cleveland, U. S. A.
Yacht. *w.* Paris.
Zeitschr. f. d. Gesamte Turbinenwesen. *w.* Munich.
Zeitschr. d. Mitteleurop. Motorwagen. Ver. *s-m.* Berlin.
Zeitschr. d. Oest. Ing. u. Arch. Ver. *w.* Vienna.
Zeitschr. d. Ver. Deutscher Ing. *w.* Berlin.
Zeitschr. f. Werkzeugmaschinen. *b-w.* Berlin.

# CURRENT RECORD OF NEW BOOKS

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Annual Report of the Smithsonian Institution, 1908. Size, 9 by 6 in.; pp., 801. Ills. Washington: Government Printing Office.

Valve Setting. By Hubert E. Collins. Size, 9 by 6 in.; pp., 209. Ills. Price, $2. New York and London: Hill Publishing Company.

Fire Tests with Fire Extinguishers. Size, 8½ by 5½ in.; pp., 16. Ills. Price, 2/6. London: The British Fire Prevention Committee.

Natural Sources of Power. By Robert S. Ball. Size, 8½ by 5½ in.; pp., xvi, 348. Ills. Price, $2. New York: The D. Van Nostrand Company.

Principles of Mining. By Herbert C. Hoover. Size, 9 by 6 in.; pp., 199. Ills. Price, $2.50. New York and London: Hill Publishing Company.

Railroad Engineering. By Walter Loring Webb. Size, 9½ by 6½ in.; pp., 296. Ills. Price, $3. Chicago: American School of Correspondence.

Mining Methods in Europe. By Lucius W. Mayer. Size, 9 by 6 in.; pp., 169. Ills. Price, $2.50. New York and London: Hill Publishing Company.

Direct and Alternating Current Testing. By Frederick Bedell. Size, 8½ by 5½ in.; pp., 263. Ills. Price, $2. New York: The D. Van Nostrand Company.

The Elements of Mechanics of Materials. By C. E. Houghton. Size, 8½ by 5½ in.; pp., 186. Ills. Price, $2. New York: The D. Van Nostrand Company.

The Steam Turbine. By James Ambrose Moyer. Size, 9 by 6 in.; pp., 370. Ills. Price, $4, 17/-. New York: John Wiley & Sons; London: Chapman & Hall.

Gold Refining. By Donald Clark. Size, 8½ by 5½ in.; pp., 123. Ills. Price, 12/6. Sydney: Australian Mining Standard; London: Sir Isaac Pitman & Sons.

The Economy Factor in Steam-Power Plants. By George W. Haskins. Size, 9 by 6 in.; pp., 133. Ills. Price, $3. New York and London: Hill Publishing Company.

Gas Engine Theory and Design. By A. C. Mehrtens. Size, 8 by 5 in.; pp., 256. Ills. Price, $2.50, 10/6. New York: John Wiley & Sons; London: Chapman & Hall.

Railway Signalling in Theory and Practice. By James Brandt Latimer. Size, 8 by 5 in.; pp., 420. Ills. Price, $2.50. Chicago: MacKenzie-Klink Publisring Co.

Road Preservation and Dust Prevention. By William Pierson Judson. Size, 9 by 6 in.; pp., 144. Ills. Price, $1.50. New York: The Engineering News Book Department.

Laboratory Notes on Industrial Water Analysis. By Ellen H. Richards. Size, 9 by 6 in.; pp., 49. Price, 50 cents, 2/-. New York: John Wiley & Sons; London: Chapman & Hall.

Bricklaying System. By Frank B. Gilbreth. Size, 9 by 6 in.; pp., 321. Ills. Price, $3. New York and Chicago: The Myron C. Clark Publishing Co.; London: E. & F. N. Spon.

Electric Power Conductors. By Wm. A. Del Mar. Size, 7½ by 5 in.; pp., 339. Ills. Price, $2. New York: The D. Van Nostrand Company; London: Crosby Lockwood & Son.

Structural Details or Elements of Design in Heavy Framing. By Henry S. Jacoby. Size, 9 by 6 in.; pp., 368. Ills. Price, $2.25, 9/6. New York: John Wiley & Sons; London: Chapman & Hall.

Smolley's Parallel Tables of Logarithms and Squares. By Constantine Smolley. Size, 7 by 5 in. Price, $3.50. New York: The Engineering News Publishing Company; London: Archibald Constable & Co.

Analysis of Mixed Paints, Color Pigments and Varnishes. By Clifford Dyer Holley and E. F. Ladd. Size, 8½ by 5½ in.; pp., xi, 238. Ills. Price, $2.50, 10/6. New York: John Wiley & Sons; London: Chapman & Hall.

Report of the Proceedings of the Forty-third Annual Convention of the Master Car Builders' Association held at Atlantic City, N. J., June 21, 22, and 23, 1909. Size, 9 by 6 in.; pp., 681. Ills. Chicago: Published by the Association.

Report of the Proceedings of the Forty-second Annual Convention of the American Railway Master Mechanics' Association held at Atlantic City, N. J., June 16, 17 and 18, 1909. Size, 9 by 6 in.; pp., 403. Ills. Chicago: Published by the Association.

Locomotive Dictionary, 1909 Edition. Compiled for the American Railway Master Mechanics' Association by George L. Fowler. Size, 12 by 8 in.; pp., 539. Ills., 5,266. Price, $16. New York: The Railroad Age Gazette.